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Contents.

	PAGE
Methods of Purchasing Pig-Iron	303
The Death of Mr. Charles Jones, Past-President of the I.B.F.	304
Forthcoming Events	304
Obituary	304
Effect of Small Quantities of Nickel upon High-grade Bearing Metal	304
Designing and Equipping a Foundry Laboratory	305
Tensile and Bending Tests of Malleable Cast Iron	307
The Testing of Moulding Sands with Special Reference to Standardisation	308
Foundry Queries	311
Institute of British Foundrymen	312
Eustis Electrolytic Iron-making Process	314
An Apprenticeship Course in Foundry Practice—LXI	315
Moulders of the Industry—No. 16	317
Contracts Open	317
Belt Driving Principles	318
Steam Jet Furnace Developments	319
Repairing Furnace Bottoms	319
Trade Talk	320
Personal	320
Company News	320
Iron and Steel Markets	322

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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Methods of Purchasing Pig-iron.

Because of the demand of the International Association for Testing Materials for the supply of pig-iron to composition definitely keeping between limits or showing maximum tolerances, coupled with a similar request from the Paris International Foundry Congress, the whole subject has been recently much in evidence in our columns. In order to enable the foundry world intelligently to grasp the situation, it seems opportune to review conditions as they exist and leave foundrymen to draw their own conclusions.

Dealing with domestic consumption first, it should be pointed out that *it is possible to buy on analysis* at the present time. We inspected two stock lists only last week, the one emanating from a blast furnace company and the other from a prominent merchant. Both these concerns, on receipt of an inquiry, outlining a certain analysis, state definitely that there are so many tons of this analysis available, *or* a certain stock exists of a composition closely resembling that required, but, maybe, the silicon is on an average 25 points higher, and inquire whether they may deliver this or other alternative material. If the foundryman knows his business he can use most compositions by the simple process of compounding or alloying. Other smelting concerns and merchants do not supply so much to analysis, but they employ expert foundrymen as representatives, who act as advisers to the foundrymen and work out the mixtures for them for the various grades of castings to be made. Thus they assume even greater responsibility than the mere supplying of material to analysis, because unless they can produce results the expert from a competitive firm certainly will do so.

Finally, there is the last point, which is the basis of the present controversy; that is, that many concerns publish periodically the average composition of their grades. Foundrymen looking for a desirable analyses for a certain type of work choose one of these, and, on analysis, considerable variations are found. This was clearly demonstrated by Mr. H. J. Young, in his Paper given to the Institute of Marine Engineers. This gentleman, however, has on several occasions complicated the whole question by throwing doubt on the analyses currently made on cast iron, but the combination he has suggested of the technical business man and the business-like chemist should quickly overcome the present-day poor results, if they really exist. It is not unsportsmanlike repeatedly to check the chemist by submitting the same sample under several different designations. It is only for the chemist's own good, and if he cannot withstand this test then he must make room for the chemist who can.

The export of pig-iron is on a different basis, as payment is made against bills of lading, and the furnishing of a guaranteed analysis for the large quantities involved for material to be shipped to the four quarters of the earth would prevent finality being reasonably quickly established for any transaction. It would further give any dishonest foreigner the opportunity for dispute, based on no sound foundation. If foreigners insist on buying to chemical limitations they must at least appoint inspectors to certify consignments before they leave the country and preferably at the furnaces. Generally speaking, the relatively small British furnaces produce high-class material, but necessarily with larger variations from normal owing to the smaller and varying iron ore deposits being worked.

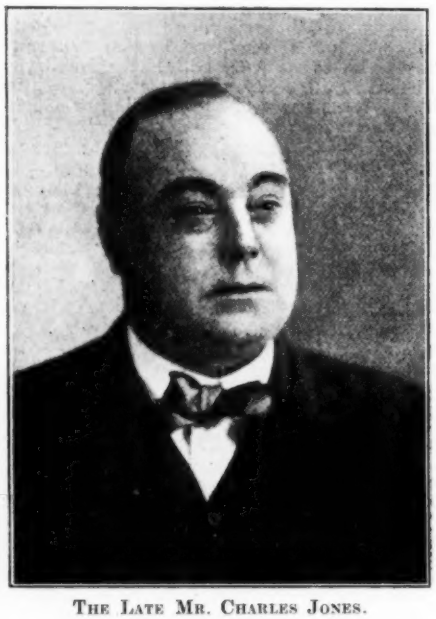
The French ironmasters have acceded to the request of the International Association for Testing Materials, but they export very little. The British have refused to appoint a Committee to go into the matter, but a section have intimated a willingness to do business on these lines, but, we anticipate, with a proviso for inspection before loading. The routine method described in Mr. J. Arnott's excellent contribution to the subject, which appeared in our last issue, clearly demonstrates that disputes as to chemical composition should be cleared up before consigning, otherwise time considerations would overshadow every other aspect of the business.

XUM

The Death of Mr. Charles Jones, Past-President of the I.B.F.

We regret to have to record the death of Mr. Charles Jones, of Ninian Foundry, Cardiff, who was President of the Institute of British Foundrymen, then the British Foundrymen's Association. Mr. Jones was born in 1844, and established the Ninian Foundry about 30 years ago. About five years ago he retired from business, leaving the control of it in the hands of his son, Mr. Charles E. Jones. About this time he had a paralytic seizure, and never really recovered. However, he visited Canada for his health in 1921, and as a result was sufficiently well to attend a Council meeting held in Birmingham in the early part of 1921.

His interest in the Institute dated from its inception in 1904. Though his presidential address was given in 1912, it could very well stand as a basis on which to build the technical education



The Late Mr. Charles Jones.

of the foundryman to-day. It was definitely constructive, and if the war had not broken out we feel certain that he would have lived to see his work bear fruit. He caused strong committees to be formed throughout Great Britain, but, unfortunately, when their findings were completed industrial conditions were such that they had to be tabled until the restoration of normal conditions. Some of the cardinal points of his address, which was after all only the expression of his every-day views, were that foundry owners must take a personal interest in the apprentice; that they should place a portion of their foundry at the disposal of the education authorities for teaching purposes; that technical teachers must use simple language; that apprentices must not under any considerations be treated as a money-making proposition; that the jobbing foundry is the best type of place in which to teach the apprentice his trade.

To Mrs. Jones and family we offer on behalf of the foundry trades our sincerest sympathy in the loss which they have sustained.

Mr. Rex Lambert, A.R.S.M., has been appointed sales manager to the Ryarsh Sand Company, Limited, Westminster, London, S.W. Mr. Rex Lambert is a son of Mr. Wesley Lambert, the retiring President of the London Branch of the Institute of British Foundrymen.

Correction.—We regret that a printer's error occurred in the advertisement of Mr. Alex. Hammond, "Boxted," Slough, which appeared on page 22 in our last issue. The prices quoted for ladles should have read as follows: New 1-ton "Jackman" worm-geared crane ladle, £20; good ¾-ton ditto £32; very good 8-ton worm-geared crane ladle, £50.

Obituary.

Mr. W. H. Bostock has died at his residence, "The Woodlands," Avenue Road, Wolverhampton, at the age of 63 years. Until very recently he was connected with the firm of Tolley, Son & Bostock, ironmasters, The Green, Darlaston.

Professor Herbert McLeod died last week at the age of 82. At the age of 19 he became assistant chemist at the Royal School of Mines, engaging in research, chiefly on the physical side. In 1871 he was appointed Professor of Chemistry at Cooper's Hill, a post which he held for thirty years.

Mr. J. Lewis, of Lydney, died recently. The deceased gentleman was almost 71 years of age, and a few years ago resigned the position of works manager at Richard Thomas & Company's extensive tinplate mills at Lydney and Lydbrook, where he had held that office for twenty years.

Mr. Thomas McBean, proprietor of Thomas McBean & Company, iron merchants and brokers, of 15, Warwick Chambers, Corporation Street, Birmingham, and a partner in the firm of W. J. Carter & Company, iron, steel and metal merchants, 6, Lloyd's Avenue, London, E.C.3, died on September 15 in his 64th year.

Effect of Small Quantities of Nickel upon High-Grade Bearing Metal.*

By A. H. Mundey and C. C. Bissett.

This Note gives a brief account of a practical trial of the effect of varying small quantities of nickel upon a tough and well-reputed bearing metal. For this test the well-known alloy consisting of tin 93 per cent., antimony 3.5 per cent., and copper 3.5 per cent. was chosen. The authors state that nickel is now found to be added to some considerable extent, possibly as a means of identification, but some merit is also claimed for it. The results of the usual physical tests were:—Tensile, compression and hardness tests gave no indication of improvement due to the nickel; in fact, the alloys were rather inferior when containing nickel. Running trials on the Thurston machine on strictly comparative lines showed practically no change as between nickel and non-nickel alloys. The comparison of hardness at varying increased temperatures exhibited no improvement. Probably the most interesting feature was the structure under the microscope. In the case of the alloy with no nickel, the hard copper-tin constituent was very marked in its characteristic crystalline formation. The presence of nickel even in small quantities resulted in a great diminution of this crystalline structure, and the structure was only in a measure restored by the addition of more copper. The beneficial results of nickel in alloys of the character employed are yet to be demonstrated.

Forthcoming Events.

OCTOBER 13.

Institution of British Foundrymen (West Riding of Yorkshire Branch):—Meeting at Bradford. Presidential address. "Foundry Cupola and Mechanical Charging," Paper by A. A. Liardet, M.I.Mech.E.

OCTOBER 15-20.

Cycle and Motor Cycle Exhibition:—Olympia, London.

OCTOBER 16.

Institute of Metals (Birmingham Local Section):—Meeting at Birmingham. Chairman's address, F. Johnson, D.Sc.

OCTOBER 17

Institute of Production Engineers:—Annual general meeting in London. Presidential address by J. D. Scaife.

OCTOBER 18.

Institution of British Foundrymen (London Branch):—"Recent Developments in Foundry Practice," Presidential address by V. C. Faulkner.

OCTOBER 19.

Institute of Metals (Scottish Section):—Ordinary meeting at Glasgow. "Large Metallic Crystals and some of their Properties," Paper by Professor H. C. H. Carpenter, F.R.S.

Institution of Mechanical Engineers:—General meeting in London. Presidential address by Sir John Dewrance, K.B.E.

OCTOBER 22.

Institution of Mechanical Engineers (Graduates' Section):—Ordinary meeting in London. "Four-Wheeled Brakes for British Light Cars," Paper by J. Harrison.

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* Paper read before the annual autumn meeting of the Institute of Metals.

Designing and Equipping a Foundry Laboratory.

By H. H. Shepherd, M.I.Brit.F.

During the past 15 or 20 years there has been a universal and very determined attempt on the part of metallurgical institutions and scientific craftsmen to raise the status and efficiency of the foundry and its workers. The Great War provided a forceful impetus to these endeavours, and one can safely state that science has now rooted itself into the foundry, as in all other important industries. Practical scientific control is gradually becoming recognised as a *sine qua non* of foundry organisation, and it is a gratifying reward to the pioneer workers in the cause to see the gradual passing away of the "old conservatism" which for so many decades kept the foundry more in line with the days of Tubal Cain than those of the twentieth century.

We in England have been slower than America and Germany to recognise that the application of science to the foundry is not "a new craze" with industry, but is the natural result of evolution in industry; and just as we must, to a large extent, keep pace with natural evolution, as affecting our daily lives, so we must keep pace with industrial evolution. It is essential to the safety of our trade, to our existence as a nation, and to us individually.

British foundry owners are making amends for that previous "aloofness"; the past few years has seen scientific control welcomed into the foundry; many foundries have established laboratories, and their owners often admit the considerable benefit that has been derived from the services of a well-trained metallurgist having at his disposal a properly equipped laboratory.

The deplorable slackness in trade has undoubtedly proved a very serious setback to any reconstruction or organisation schemes, but with the coming of better times the advance, the modernising of the foundry will go steadily on; many more foundries will be prepared to equip efficient laboratories, because their value has been proved and is every day shown to be a considerable asset to modern foundry practice.

The writer submits the following scheme of designing and equipping of a foundry laboratory, with the hope that it may be helpful to the carrying out of such a project.

The Status of the Laboratory.

When a projected scheme for the founding of a laboratory is being considered, the first essential is that there should be unanimous agreement between those who sanction the founding, those who are to control its expenditure, and the person who is to take charge, that is, the chemist or metallurgist, upon the following points:—

(1) That a laboratory is not a "luxury" but an essential part of the works.

(2) That it is indirectly a productive department.

There is far too great a tendency on the part of some firms who possess a laboratory to view with considerable suspicion any request for financial aid for the department, on the grounds that "the laboratory is not a productive department"; and it is the firm opinion of the writer that unless the two aforementioned points are recognised practically by giving a reasonable amount of encouragement and financial aid to the laboratory, then any thoughts of founding one should be scrapped at once. Nothing is more nauseating to the person in charge than to be told—should he require an additional piece of apparatus or even a supply of a chemical which may not be at all costly—that his department is not productive and therefore does not warrant expenditure.

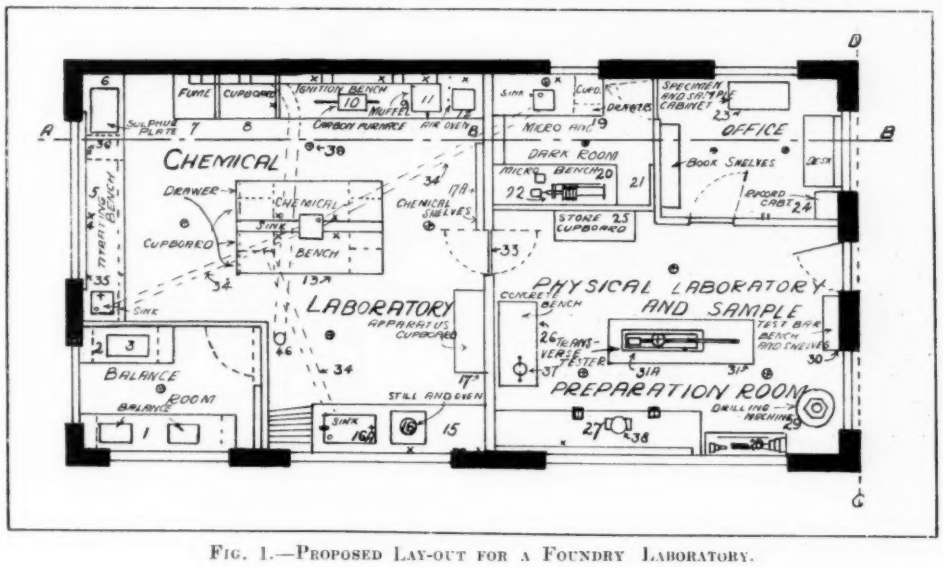


Fig. 1.—Proposed Lay-out for a Foundry Laboratory.

Another idea which is unfortunately far too prevalent is that any kind of place in any position is suitable for a laboratory. It is not by any means uncommon to find that upon being engaged a metallurgist is confronted with a proposition like this: "Now we purpose this room (or building) to be equipped as the laboratory. It is not large, etc., but it is close to the foundry"—probably so close as to form a receptacle for all the dust and dirt which the foundry can create. The writer has seen a laboratory established next door to the bricklayers' stores, and the mixing of cement outside the door of the laboratory did not lighten the task of the chemist in keeping the dust down in a place where satisfactory ventilation could be brought about only by keeping the door open. In another case the laboratory was situated next door to a not too sanitary lavatory; while a third case was that of placing the laboratory next to a boiler slack heap. All attempts to get the slack removed proved in vain.

Badly drained sites are not infrequently selected. In view of the cases cited and others with which the writer has been personally acquainted, he makes no apology for a somewhat lengthy consideration of the status of the laboratory. The chemist or metallurgist has no wish to be housed in a glass case any more than in a disused and tumbledown building which has stood derelict probably for years, until someone conceived the brilliant idea of establishing a laboratory in it.

D

Site.

The choice of a suitable site is a very important factor which has considerable bearing upon the reliability and rapidity with which the work can be dealt with.

The site should be on the same level as that of the whole works, that is, it should not be in a hollow; well-drained ground is essential. The site selected should not be, as previously instanced, close to fuel, sand, or anywhere where the work of the department is likely to be hampered by dust; further, it should not be in a position where the vibration of heavy machinery or steam hammers, etc., is easily transmitted to the laboratory, otherwise weighing and other delicate operations will be jeopardised. If the works is large, the site should not be too close to the offices, since in most cases it is the works staff who have to visit the laboratory more frequently than the office staff. The ideal site for most considerations is a central one within easy reach of any department.

A further consideration which should be borne in mind when deciding upon a site is the gas and water supply; these should be ample for the needs and delivered at good pressure.

The scheme set forth herewith may prove too expensive for some works, but it can, of course, be modified to suit the particular foundry it is required for. Benching could be cut down, etc., but cramping should be avoided. "Ample room" should be the golden rule in laboratory design. Apparatus can be selected with due regard to the type and quantity of the tests. It should, however, be remembered that this is the chemist's job, and further, the writer would point out, that however limited a scheme may of necessity be, every endeavour should be made to install a complete metallographic outfit. The microscope is becoming more and more an apparatus of vital necessity in metallurgy and works practice: its use will often save hours of chemical testing—testing which may prove useless, and if used in conjunction with chemical and physical testing, it undoubtedly increases the information and the value of the investigation.

The laboratory indicated has been designed especially with a view to foundry work, of a foundry of medium or large size. It will very comfortably allow for the working of a minimum staff comprising the chemist, two assistant chemists, and, if desired, an additional man in the physical laboratory.

The Building.

The layout of the laboratory and its accessory departments, indicated by Fig. 1, shows that the whole is housed in one building measuring overall 39 ft. × 20 ft. × 20 ft. It is provided with two roofs, the roof proper and a secondary flat one of wood, as a plastered roof soon becomes an intolerable nuisance. This sheaths the laboratory off at a height of 12 to 14 ft. The flat roof or ceiling is suggested in consideration of the lighting and ventilating schemes. The writer prefers a secondary flat roof to a glass or semi-glazed roof proper, for apart from the disadvantages of a single roof, a glazed roof makes a laboratory, which is always inclined to be overheated, unbearable in even moderately hot weather. Entrance to the building is provided by one door only, leading into the physical laboratory. The idea of having an additional entrance through the chemical laboratory has not been lost sight of, but has been purposely omitted. One entrance as positioned ensures the chemical department being kept free from excessive dust and also from gusts of wind when the door is opened. The foregoing considerations may appear simple, and their importance is well known to any chemist who has charge of a laboratory situated at ground level. The writer recalls to mind an excellently built and equipped laboratory, which possesses the one very serious fault, that is the door, about 3 ft. 6 in. wide, opened directly into the centre of the end of the laboratory, which caused the chemists a considerable amount of trouble through dust, blown out or "blown back" burners, etc. If an entrance is desired into the chemical department direct from the outside, it should be by means of a porch and double doors.

Natural lighting is provided by side and end windows, which should possess as large a frontage as permissible; the three large ones, indicated in Fig. 1, could be larger even than given in the plan, to the extent of 1 to 2 ft. Wood-framing is recommended, not iron, on account of the latter's tendency to corrode and peel under the action of fumes, etc. The height from the floor level to the framing bottom should be from 3 ft. 3 in. to 3 ft. 6 in., while the height of the framing itself should be such that the actual window area has a height of at least 5 ft. The ventilating panels are designed to open inwards, so as to aid the creation of a draught system in conjunction with the ventilating fan. In the chemical laboratory there should be four or five opening panels, according to the adopted size of the two large windows. The physical laboratory should have at least four. The ventilating or opening panels may, if desired, be of double type, but single panels have the advantage that the draught can be more easily controlled to suit weather conditions.

The window of the dark room should be of the domestic kitchen type, fitted with a light tight blind, similar to that illustrated in Fig. 2.

Before passing on to consider in detail decorating, furnishing, and fitting, a little consideration of the flooring will no doubt be of interest; it is suggested that the physical department be laid with concrete, and the chemical laboratory, balance room, dark room, and office should have the con-

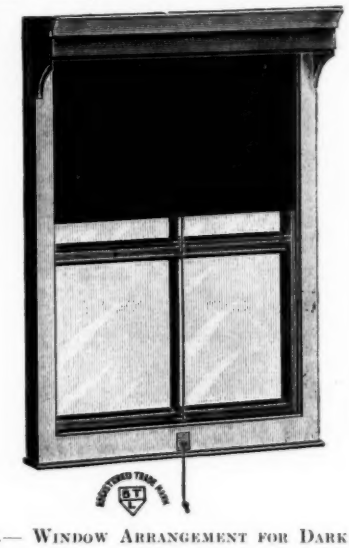


Fig. 2.— Window Arrangement for Dark Room.

crete base laid with wooden blocks. The latter are increasingly coming into use on account of their neatness, cleanliness, and long life. The writer understands that there is a patented flooring on the market which is said to be acid proof.

The building is divided into two main rooms—the chemical and the physical laboratory. Division is made by a part-glass partition (Fig. 1); one portion forms the wall of the dark room. This section should be of double thickness to ensure light tightness. The glazed portion should have clear glass panellings at least 4 ft. high. Division between this latter section and the wooded section is made by a door leading from the chemical to the physical laboratory.

The chemical department has an interior measurement of 20 ft. × 19 ft. 6 in.; the balance room 9 ft. × 6 ft. This is divided from the laboratory by a glazed partition, the glass commencing at a height of 3 ft. 3 in. to 3 ft. 6 in. from the floor. The balance room should be sheathed off at a height of 9 ft. with a light wood, as three-ply, or probably better, Poilite panelling. The dark room and office should be sectioned off in a similar manner, but particular care must be taken to ensure the dark-room ceiling being light tight. The office and dark-room inside measurements are 8 ft. 6 in. × 7 ft. and 8 ft. × 6 ft. 6 in. respectively; entrance is provided by doors 6 ft. 6 in. × 2 ft. 3 in. wide.

Decorating.

It is fairly general knowledge that the painting and decorating of a modern works is usually of a

standard scheme for the plant and offices; but however satisfactory and strictly this may be adhered to by the firm's executives, it should certainly be waived aside in the case of the laboratory. The essential in this instance is *light*, and the ideal colour for the interior of a laboratory is pure white, while the ideal way of decorating the walls in accordance with this scheme is by *leadless* white glazed tiling. In some cases this may not be practicable on account of expense; the alternative is white *paint*. Whitewash, which is far too often employed, should not be tolerated; distemper of good washable qualities may be entertained where cost considerations are of absolute minimum expenditure, but it will be found well worth the little extra cost to employ a white paint. It is essential if paint is used that it should be leadless: paints containing lead very soon lose colour and become dirty-looking on account of the the action of sulphur fumes, particularly those of sulphuretted hydrogen, which converts the lead base into black lead sulphide.

Furnishing.

A foremost consideration under this heading is bench room. In the design submitted ample room has been allowed for, and also, what may appear to be a new departure to some workers, a specially designed titrating bench has been introduced. The writer has tried and proved the advantage of this arrangement in several laboratories working under dissimilar conditions, and its adoption is well worth while in works laboratories where burette work forms a considerable portion of the analytical testing.

The practice of carrying burettes round the laboratory to any particular place cannot be too strongly condemned, as it very often results in wasting a large amount of time and risking the life of the apparatus. With the adoption of a titrating bench the burettes can always be kept in one place. They can be supplied with automatic feeds, which saves time, and the probable spilling of solution through over-filling due to the clumsy method of filling by hand from the reagent bottle.

Balance Room.

The two balance benches (Fig. 1, 1 and 2) should be of rubbed slate or York stone. They should have a width of about 1 ft. 9 in. One bench is arranged to take the fine balances. The support for these benches must be very rigid to avoid vibrations: brick column supports are best. A set of shelves (Fig. 1) are provided in the balance room for the storing of delicate apparatus, standards, etc.: these measure 3 ft. × 7 in. × ½ in. overall. They should be fitted with glass sliding doors.

(To be continued.)

Tensile and Bending Tests of Malleable Cast Iron.

By L. Piedboeuf.

During a discussion on suitable test pieces for malleable cast iron at Nancy, M. Piedboeuf suggested the use of a test bar of the American pattern for determining the bending by impact. Since others suggested the tensile test piece, M. Piedboeuf decided to try a practical experiment on the utility of this form of test piece for white heart malleable in pieces of light section. The experiments were made on series of four bars of the sections shown in the sketches. The dimensions were calculated so that all the sections were of the same area (117 mm.²) and the distance between the gauge points was 100 mm. The results of the tensile tests were, therefore, directly comparable, and would at once show which were the best sections from this point of view. The following table gives the results of three tensile tests and one bending test.

Section No.	1	2	3	4
Test No. 1—Elongation per cent.	1.8	1.2	1.9	9
Ultimate tensile tons per sq. in.	8.2	15.2	15.2	22
Test No. 2.—Elongation per cent.	1.2	3.5	5.2	5.5
Ultimate tensile tons per sq. in.	10.7	15.8	17.1	17.1
Test No. 3.—Elongation per cent.	3	5.8	—	10
Ultimate tensile tons per sq. in.	16.5	22	19	17.1
Bending test	180° without fracture.	90° broke at 90°	180° without fracture.	270° without fracture.

The test pieces of each series were cast together and were decarburised in the same furnace. The test pieces were cast when the foundry was not engaged on routine work. The mixture used consisted of hematite with 2 per cent. of silicon and gave a considerable number of wasters, which explains to some extent the defects encountered. It was noticed that defects were especially prevalent in the thick pieces, those of light section being much cleaner. For the second series decarburation was only carried on for seven days, during which the temperature was maintained at 1,000 deg. C. for 24 hours.

Series 1 and 3 decarburation was for 8 days, 60 hours being at 1,000 deg. C.

Observations on Tests.

Test Piece, Section 1:—In Tests 1 and 2, the test pieces broke outside the gauge marks in consequence of casting being spongy. Test 3; these broke twice outside the gauge marks; fracture showed black centre, decarburation incomplete.

Test Piece, Section 2:—First test; broke outside gauge marks as it was a defective casting. Second test; broke outside gauge marks; on a repeat test the facture was clean and between the gauge points. The third test gave clean fracture between gauge marks. A fourth test piece of cylindrical section which broke outside the gauge points gave an ultimate tensile stress of 21.5 tons per sq. in. on a repeat test: the elongation was not determined.

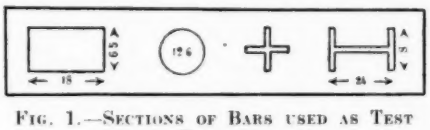


Fig. 1.—Sections of Bars used as Test Pieces.

Test Piece, Section 3:—First test; broke outside gauge marks, dirty casting. The fracture, of cylindrical form, occurred at one end. Second test; clean fracture between gauge points. Third test; first broke outside gauge points, on re-test fracture occurred between points, elongation not measured.

Test Piece, Section 4:—Tests 1, 2, and 3, clean fracture between gauge points.

Bending Tests:—The test pieces of H section, those of the cross section and the rectangular section gave much better results, and were stiffer than the cylindrical section. The H section gave by far the best results.

Conclusions.

(1) The ordinary, cylindrical, tensile test piece is not suitable for white-heart malleable cast iron of light section; (*a*) because of difficulties in casting; (*b*) because the decarburation will genereally be less complete than it is in the articles the test piece is supposed to represent.

(2) The test pieces of H or cruciform sections give the best results, the sections approaching those of the castings they represent. In the test bars of cruciform section the ends were made cylindrical, and it was always in these ends that defects were found.

(3) Test pieces of H and of cruciform section give very good results in bending tests: they have a marked superiority over those of cylindrical section.

(4) The investigation proved the advisability of selecting test bars of H or cruciform section, and, in general, sections of the least possible thickness. Round, oval, square or rectangular sections should be avoided.

* Translated from a Paper presented to the Paris Foundry Congress.

The Testing of Moulding Sands with Special Reference to Standardisation.*

By C. W. H. Holmes, M. Met.,' Birtley.

(*Continued from page 298.*)

Some definite data on bonding is very desirable. Fig. I. shows diagrammatically the influence of milling upon the *bond value* and the tranverse strength.

In dealing with such small quantities of sand as are available from time to time in research work, the dye adsorption test is of great value, principally because there is nothing at present to replace it.

The most valuable indication of the practical strength of the bond is given by either the transverse or, preferably, the overhanging test as developed by R. J. Doty.

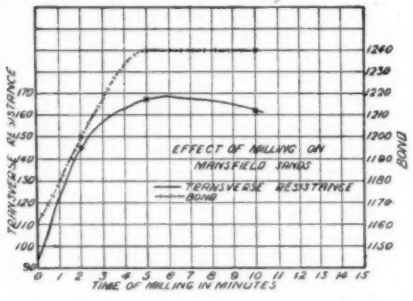


Fig. 1.—Showing the effect of Milling on the Transverse Strength and Bond of Mansfield Sand.

This test, which will be indicated later, takes account of both the quantity and quality of the bond, and also of the distribution of this bond over the available surface and of the number of grain contacts per unit volume.

Venting Properties of Moulding Sands.

Before considering the venting properties of moulding sands, the fact that permeability and porosity are two essentially different things must be appreciated.

A substance is only permeable when gases can pass through it; a substance is porous when it contains cavities; and the ratio of the volume occupied by these cavities to the total volume is known as the porosity.

If a substance is permeable it must be porous, but the converse is not true.

For example, a piece of coke may have a porosity of 40 per cent., and yet any effort to pass gas through it would result in utter failure; in other words, it is impermeable.

Further, if samples of clean sand with rounded grains 1, 0.25, and 0.05 mm. diameter were taken, it would be found in each case that the porosity (under similar ramming conditions) was the same; but it would show that there was a very great difference in their permeability or venting properties.

The sand of so fine a grain as .5 mm. would offer a much greater resistance to the passage of gases than the coarse grained 1-mm. sand.

Various methods have been suggested from time to time for measuring the permeability of sands by determining the time required to pass a certain volume of air through a definite body of sand.

These methods are not complete and are not comparable one with another.

Sand permeability may be compared with electrical conductivity, and in this connection it is worthy of note that there is a definite standard of electrical conductivity (or rather of its converse resistance) which is known as the ohm.

All resistances are measured in terms of this unit, and the resistance of one centimetre cube of any substance is known as the specific resistance of that substance.

For example, the specific resistance of copper is $1.58 \times 10^6 \left(\text{or } \frac{1}{1.580.000} \right)$ ohm, at the temperature of melting ice; and as the resistance varies directly as the length and inversely as the areas of cross-section, the resistance of any copper conductor can be calculated.

It would appear from analogy that once one has determined the permeability (or rather the impermeability, for that is what is actually measured) of any body of a certain sand rammed to a certain density, we could calculate the impermeability of any other body of the same sand rammed to the same density.

Unfortunately, it is not practical to ram up a body of sand more than about an inch thick, so that its permeability is the same throughout its depth, no matter how the ramming is done.

It is common knowledge that a deep mould rammed up on a jolt machine is harder at the bottom than the top, whilst in squeezing a deep mould special precautions have to be taken to prevent the mould being too soft at the bottom.

Hand ramming is out of the question, as it is too irregular. As a result of this reasoning one arrives at the conclusion that in testing moulding sands for permeability, everyone must decide upon certain dimensions for the test-piece and adhere closely to them if results are to be comparable.

Further, the test-pieces must be rammed under identical conditions and tested under similar pressures of air. Time and space do not permit of a description of the method proposed by the American Foundrymen's Association's Joint Committee on Moulding Sand Research for testing the permeability of sands.

Reference should, however, be made to this description, when it will be seen that all the variables are so standardised as to render accurate and comparative results possible; the permeability is there defined as the volume of air forced through unit volume of sand in unit time by unit pressure.

Recommendations are made that each sand be tested with varying moisture contents, with a view to determining at what percentage of moisture maximum permeability is obtained.

The writer advises that tests be made to determine the effect of different degrees of ramming on the permeability of the sand—not out of curiosity or any desire to complicate the test, but for the following very practical reason.

It is common knowledge among foundrymen that some sands are so susceptible to ramming conditions that there is little or no margin between soft-ramming, with consequent swelling, washing, or buckling of the mould, on the one hand, and hard ramming, resulting in blowholes and scabs, on the other. Other sands can be rammed very hard and yet behave well in practice.

The former class of sands can be detected by a rapid decrease in permeability with increased ramming on test. Such sands are costly by virtue of the difficulty in working with them, for either production is hampered or an excessive percentage of wasters produced.

Both the variations in permeability occurring with varying moisture or ramming are closely connected with the internal structure or grading of the sands, and no survey of our knowledge of the variation of permeability with grain size and moisture content would be complete without reference to the work of H. A. Schwartz, who has dealt with it fully both from the practical and mathematical standpoints.*

As the result of his researches he formulates the following conclusions, upon which the writer comments:—

* A Paper presented to the Paris Conference.

* H. A. Schwartz, "Proceedings A.F.A., 1922."

(1) *Sands of absolutely uniform grain size are the most pervious.*

(But the finer the grain the lower the permeability, the porosity being unchanged.)

(2) *The relation between grain size and perviousness is too complicated to permit drawing any conclusions.*

(3) *The perviousness can be readily and cheaply determined by means of direct experiment.*

(4) *The sieve test of sand is of academic interest only, and means practically nothing in a study of the commercial properties of moulding sands.*

The writer has already dealt at length with the grading of sands, and has criticised the sieve test rather severely; but if a sand is shown by actual test to be impermeable, the case is only diagnosed as being impermeability, useful to know, but not very helpful.

The disease may or may not be economically curable, but a careful grading of the sand (preferably with the elutriator) and a little thought will often show us where the trouble lies, and will assist us in deciding whether we can improve the permeability by blending with another sand or whether it will be cheaper to scrap the defective sand altogether.

(5) *The perviousness of moulding sand depends on its moisture content, and in the beginning increases with increase in moisture.*

One of the most important results in this research lies in the fact that the finer the sand the greater the increase in permeability with increased moisture content, the maximum effect being obtained in all cases with about 71 or 72 per cent. of moisture.

What influence has the daily routine of milling and casting upon the permeability of the sand? R. J. Doty has shown,* in a carefully conducted research on a synthetic steel moulding sand extending over 22 days, that the average grain size increased from 0.0128 in. to 0.0148 in. owing to incrustations of clay forming around the grains of sand. Unfortunately, no permeability figures are given; and as we cannot predict the permeability from the sieve tests or from the average grain size, we can only say that the permeability is probably improved. The writer has not also shown this increase in grain size to occur in naturally bonded green-sands taken from the mould face; but has further shown that milling decreases the percentage of sand grade and increases the percentage of silt and clay grades, thereby causing a positive though definite decrease in the permeability.

Whilst it is obviously possible in certain circumstances for these phenomena of increase and decrease in permeability to balance each other, results go to show that with naturally bonded sands and average British milling equipment, the sand tends to become finer and to lose its uniformity of grading and hence to become less permeable. It is worthy of note that in England, and probably universally, large sums of money are wasted annually owing to faulty sand-mill design, not only because the sand is partially degraded, but also in wasted horse-power. (The writer has dealt more fully with this matter elsewhere.†)

Strength or Cohesiveness of Sands.

The nature or valuation of the bond has already been considered in parts 2 (*c*) and 2 (*d*), and we have arrived at the conclusion that, although we may obtain much information regarding either the amount of bond or its quality, it is only by testing the actual strength of the sand that we can take into account many other essential factors, such as the total surface to be coated and the even or uneven distribution of the bond.

It would appear to be a simple matter to ram up a test-bar in sand and to determine the load required to break it; and so it is. Where the difficulty lies is in ramming up two or more test-bars from the same sand so that all three will give concordant figures.

This matter has been carefully investigated by R. J. Doty,‡ who was unsatisfied with the accuracy of the methods he employed and tried in turn: the overhanging bar test, the horizontal tensile, vertical tensile, and the overhanging bar test again, with certain refinements in filling the core-box and ramming up the test-piece.

Concordant results were now obtained from different bars made with the same sand.

Another difficulty was then encountered: sands that were obviously stronger than the average did not show a corresponding increase of strength on test.

This was found to be due to the fact that the stronger sands, bearing more clay than the average, had a higher porosity when filled into the core-box (by volume).

A standard weight of sand (1,000 gm.) was then taken and rammed to a standard volume, and so as to avoid variations due to different moisture contents, a standard weight of dry sand was taken. For example, if a sand containing 5 per cent. of moisture was to be tested, 1,000 gm. of the sample would contain 50 gm. of water and only 950 gm. of sand; hence 1.050 gm. of the sample would be taken, so that in all cases 1.000 gm. of dry sand would be rammed up for the test.

(Working independently, the writer arrived at the same conclusions as Mr. Doty as regards working on a definite weight rather than a definite volume. The question of variation with moisture content did not, however, obtain in his case, as all sands were tested at a predetermined moisture content.)

The connection between this matter and the increase of permeability with added water, noted by H. A. Schwartz, is most interesting.

Concordant results were obtained by Doty after all the precautions noted above were taken, and this method has formed the basis of the method proposed by the American Foundrymen's Association Joint Committee on Moulding Sand Research.*

This method, which is too detailed to describe here, should be referred to; and if at first sight it should appear to be somewhat complex, it must be borne in mind that none of the refinements has been added save to overcome some difficulty which has occurred during the preliminary research

SELECTION OF STANDARDISATION OF TESTS.

Chemical Analysis.

The brassfounder may dispense with the chemical analysis of moulding sands; the successful steelfounder will never be able to do so, and the writer recommends that this test be used intelligently when (and only when) it is needed.

In analysing moulding sands, the following precautions (which are frequently neglected) should be observed.

The filtrate from the bulk of the silica should be again taken to dryness, and the remaining silica extracted.

Titanium should always be estimated, as it very frequently occurs in amounts too large to be disregarded.

No matter how high an opinion an operator may have regarding the accuracy of his work, he should under no circumstances "estimate" the alkalies by difference on the assumption that his other determinations are correct.

Mechanical Analysis.

The logical and practical superiority of elutriation, followed by separation of the sand-grade on round-holed sieves, over the sieve test is usually performed, has been fully discussed, and is supported by the figures in Appendix I.

This test is useful in that the total grain surface may be determined from its results, and also defects in the mechanical composition affecting the permeability may be traced; further, we can obtain the ratio of static to mobile bond.

There is much food for thought in the mechanical analysis of sands, and it is doubtful if we can afford to dispense with this test.

The following precautions should be observed in using the Crook type of elutriator:—

The water should be at a uniform temperature of 15 deg. C., and should be reasonably free from dissolved air and from organic matter.

* R. J. Doty, "Proceedings A.F.A., 1922, J.I.S.I.

† Paper read before Newcastle Branch, I.B.F., 1922.

‡ "Proceedings A.F.A., 1923."

* "Proceedings A.F.A., 1923."

The apparatus must be absolutely vertical, especially the sand-grade tube.

The height of water in the manometer tube is no guide to the velocity of the water current, which must be checked at each estimation.

The screw clip between the sand-grade tube and the silt-grade vessel must be half-closed for the last ten minutes of the test.

Dye Adsorption Test.

The writer had hoped to complete his investigations on this test, with a view to standardising the conditions, and to incorporate the results in this Paper. Time, however, has not permitted of this.

The limitations of the test, however, have been discussed at length, and it has been shown that, for routine work at least, it is superfluous, provided, of course, that mechanical tests are carried out on the sand instead.

It has been proved to be of value in research, and as the cohesiveness can only be determined on considerable quantities of sand, it would appear to have a use in dealing with such small quantities as cannot be tested by other methods.

In connection with the *Bond Distribution Factor**,

$$\frac{\text{Transverse Strength (gm.)} \times 100}{\text{Mgm. Dye absorbed per 100 gm. Sand}}$$

this test is of use in enabling us to determine the shortest milling period required to produce maximum effect.

In carrying out the test, care should be taken to have the excess dye concentration not lower than 0.05 gm. per litre, and preferably between 0.05 gm. and 0.10 gm. per litre.

Absolute cleanliness and adherence to detail are essential if concordant results are to be obtained.

Permeability.

The American Foundrymen's Association Research Committee's proposed method has already been commended as being based on sound principles.

But because the mathematician has already put his finger on moulding-sand research as a promising field for himself, and also because foundrymen may wish to do some simple arithmetic themselves in connection with sand testing, it appears to the writer that a simplification would be useful.

Some of the units in the test are in inches and pounds and some in metric measure, and it would seem preferable to change the volume of sand under test from 5.08 cm. (2 in.) in height and 20.2268 cm. in area (3.1416 sq. in.) to 5 cm. high and 20.2 cm. area.

Also the compression is effected by three blows of a rammer weighing 14 lbs. (6,350.36 gs.) falling through 2 in. (5.08 cm.).

This gives a total of 7 ft. lbs. of work = 0.9695 kgm. on an actual area of 20.2268 cm., or a proposed area of 20.2 cm. = 0.0485 kgm. per sq. cm. on the proposed area.

Why not compress the sand by 0.05 kgm. per sq. cm., giving a total of 1 kgm. of work done on the total area of 20 sq. cm., and effecting this by a weight of 1 kg. falling 10 cm. ten times?

It seems logical to standardise and simplify each factor that may subsequently be required in calculation; and again the effects of variations in ramming can be studied more easily with ten blows than with three.

Mechanical Testing.

Here again the method proposed by the American Foundrymen's Association Joint Research Committee is far in advance of anything which has previously been suggested.

Nevertheless a similar mixture of English and metric units occurs, and this can be remedied by departing only slightly from the present dimensions of the test piece

As proposed, the test piece is 16 in. × 2 in. × 1 in., and is compressed by a weight of 20 lbs. falling 16 in. ten times, or 266 ft. lbs.

Would it not be preferable to make the test piece 40 cm. × 5 cm. × 2.5 cm. (trifling difference from the present size), giving a total surface under compression of 200 sq. cm., and to so adjust the falling weight (in kg.) and height (in cm.) that the work done per sq. cm. of surface became a simple number? The original ratio works out approximately to 0.182 kgm. per sq. cm. surface.

On the 40 cm. × 5 cm. × 2.5 cm. test piece a weight of 8 kg. dropped 50 cm. ten times would work out at 0.20 kgm. per sq. cm. of surface.

This unfortunately is four times as great as the work done per unit area in compressing the permeability test piece, and it seems probable that we may wish to correlate permeability and cohesiveness at some future date.

Not having as yet worked either of these tests exactly as specified, the writer cannot vouch as to the feasibility of the proposal, but there would appear to be a distinct advantage in carrying out both tests on sand rammed under the same conditions—say 0.10 kgm. per sq. cm.

Conclusion.

In concluding this Paper the writer wishes to appeal most strongly for international standardisation in the testing of moulding sands, both in the methods and in the units employed.

If, at this International Conference, all spoke a common tongue, its scope would be enormously increased, to the benefit of all concerned; and if we meet on common ground with our moulding-sand problems, we shall be much nearer to their solution.

So long as metals are cast, defective castings will be made; they are inevitable in every branch of the foundry trade; but to reduce them to the lowest practical limits, improved knowledge and practice in the selection, preparation and testing of moulding sands offers greater scope than any other line of research at the present day.

The defective casting is not only a loss to the foundryman; it is a charge upon almost every industry in all countries; its suppression within practical limits is of universal benefit.

APPENDIX I.

A Comparison of Results obtained with the Sieve Test and with the Elutriator, with Special Reference to the Distribution of the Bond.

Two sands have been selected, one of which is famous wherever steel castings are made, the other, an iron- and brass-founders' sand, is equally valued in its own sphere.

The sands have been graded by either the sieve test or by the elutriator, and the results of bond determinations made on the different grades are shown in Tables II, III, IV and V.

It is not proposed to discuss them, as the work done in this direction is not yet sufficient to permit of any definite conclusions.

* See J.I.S.I., Vol. 2, 1923.

Table II.—*Yellow Belgian Sand.—Siering Test.*

Grain.	%	Unit value of bond mgm. per 100 gr. of sand	Total value of bond × %	Specific surface sq. cm. per cc.	Surface of each element per 100 gr.	Mean body in relation to unit surface area mgm. of dye per sq. cm. of surface.
Sieve No. 60	1.40	4.250	5.95	125.6	8.370	0.5080
,, 90	38.70	3.800	147.06	190	12.666	0.1335
,, 120	48.00	3.420	164.16	261.5	17.434	0.0822
,, 200	5.60	5.080	28.45	393	26.200	0.0977
Passing through Sieve No. 200	6.10	17.000	103.70	—	—	—
Total	99.80	—	449.32	—	—	—

Calculated value of bond = 4.493. Actual = 4.500.

Table III.—*Mansfield Sand.—Sieving Test.*

Grain.	%	Unit value of bond mgm. of dye per 100 gr. of Sand.	Total value of bond × %	Specific surface sq. cm. per cc.	Surface of each element per 100 gr.	Mean body in relation to unit surface area mgm. of dye per sq. cm. of surface.
Sieve No. 60	0.75	950	0.712	125.6	8.370	0.1131
„ 90	9.15	1,005	9.19	190	12.666	0.0794
„ 120	27.20	1,090	29.70	261.5	17.434	0.0622
„ 300	46.30	1,270	58.45	393	26.200	0.0483
Passing through Sieve No. 200	16.60	1,873	31.05	—	—	—
Total	100.00	—	129.11	—	—	—

Calculated value of bond = 1.29. Actual = 1.225.

Table IV.—*Test on Mansfield Sand.*

A Size of grain in mm.	B %	C Unit Value of Bond mgm. of dye per 100 gr. of Sand	D Total Value of Bond ×% (B×C)	E Specific Surface sq. cm. per cc.	F Surface per 100 gr. of each separate element.	G Total Surface of each separate element $\frac{(B\times F)}{100}$	H Value of Static bond mgm. of dye per sq. cm. $\left(=\frac{C}{F}\right)$	K Mean Value of Free Bond mgm. of dye per sq. cm.	L Mean Value of total Bond mgm of dye per sq. cm.
< 1.0 >0.50	0.10	—	—	62.8	—	—	—	—	—
<0.50>0.25	3.40	0.165	0.561	125.6	8.370	0.284	0.194	0.54	0.5594
<0.25>0.10	80.20	0.330	26.466	314.2	20.950	6,800	0.158	0.54	0.5558
<0.10>0.05	8.40	0.650	5.460	628.4	41.900	3.520	0.155	0.54	0.6555
<0.05>0.01	0.90	3.630	3.267	3.1420	209.500	1.885	0.173	0.54	0.5573
<0.01	7.00	12.110	84,770	—	—	—	—	—	—
Total	10.000	—	120.524	—	—	22.489	—	—	—

Calculate Value 1.205. Estimated .1225. Static Bond 29.6.

Table V.—*Test on Belgian Yellow Sand.*

A Size of grain in mm.	B %	C Unit Value of Bond mgm. of dye per 100 gr. of Sand	D Total Value of Bond ×% (B×C)	E Specific Surface sq. cm. per cc.	F Surface per 100 gr. of each separate element.	G Total Surface of each separate element $\left(=\frac{B\times F}{100}\right)$	H Value of Static bond mgm. of dye per sq. cm. $\left(=\frac{C}{F}\right)$	K Mean Value of Free Bond mgm of dye per sq. cm.	L Mean Value of total Bond mgm. of dye per sq. cm.
< 1.0 >0.05	.20	—	—	62.8	—	—	—	—	—
<0.50>0.25	4.80	1.082	5.193	125.6	8.370	.402	.129	1.53	1.659
<0.25>0.10	78.40	0.920	72.200	314.2	20.950	16.400	.044	1.53	1.574
<0.10>0.05	5.80	6.180	35.840	628.4	41.900	2.430	.146	1.53	1.676
<0.05>0.01	1.10	13.900	15.290	3.1420	209.500	3.456	.066	1.53	1.596
<0.01	9.70	34.700	336.590	—	—	—	—	—	—
Total	100.00	—	465.113	—	—	22.688	—	—	—

Calculate Value 4.651. Estimated 4.500. Static Bond 27.6.

They are included here to demonstrate the differences between sieving and elutriation.

They show, probably for the first time, the ratio between the static and mobile bond, and will, the writer believes, provide food for thought for every progressive foundryman.

The writer wishes to thank Mr. Georges Fosseprez for having supplied him with a quantity of Belgian sands, one of which is tested in Appendix I., and also his assistants for their careful work in carrying out the elutriations and bonding tests.

Foundry Queries.

A Strike Trouble.

Owing to the Dockers' Strike in the Free State ports. I can get neither foundry coke nor pig-iron. In consequence I am using gasworks coke, and heavy scrap (a 150-h.p. Diesel engine casting). This scrap is quite clean and exceptionally tough, but in light castings it comes out so hard that it can be neither drilled nor machined. I have been thinking that by using some ferro-silicon in the catch ladle the trouble may be remedied. I would feel obliged for your advice. How much would you advise to be put into the catch ladle for a 4-cwt. catch?—W. F. M., Limerick.

We consider that the best way to get out of your present difficulty is to crush up some 50 per cent. silicon ferro-silicon and mix it with cement, forming this into rough briquettes, taking note of the amount of ferro-silicon in each briquette. These briquettes can then be charged into the cupola with the rest of your charge.

As you are using gasworks coke no doubt the sulphur will be coming out much higher than normal, and we would suggest that you experiment with soda ash, or one of the advertised ladle fluxes. Should you use these materials you must take very special precautions to slag very carefully the ladles. For a quantity of 4 cwts. add 5 to 10 lbs. of ferro-silicon.

Dorman, Long & Company, Limited, are putting into blast this week at their Clarence Ironworks what will be the biggest blast furnace in operation on the North-East Coast. The furnace is 80 ft. high, with a bosh 21 ft. 6 in. in diameter, and hearth 13 ft. in diameter. Its capacity is 2,000 to 2,500 tons per week. It is equipped with the Wrightson-Kinquist automatic charger, and all the apparatus for handling the materials is electrically driven. The furnace will be blown by a turbo-blower supplied by Messrs. Fraser & Chalmers. As this furnace will replace another now in blast there is no increase in the total number of furnaces.

XUM

Institute of British Foundrymen.

NEWCASTLE BRANCH.

Annual Meeting.

The Newcastle Branch held its Annual General Meeting on September 29, Mr. H. J. Young, F.I.C., presiding during the first part of the proceedings.

After the Secretary had read the minutes of the last meeting, Mr. Young announced that there had been nine new members elected that night, which made a total of fifty-two for the session.

The Senior Vice-President, Mr. S. W. Wise, had left the district to take up an important post in Bradford, and therefore had had to resign his presidential position in the Newcastle Branch. Mr. Young said he knew they would agree that a letter should be sent to Mr. Wise wishing him success in his new position.

With reference to the Annual Report, Mr. Young announced that, owing to a printer's error, a paragraph had been omitted concerning the inauguration of the Junior Section, which had taken place during the last session, and it had been agreed in Council that this paragraph be inserted in the next circular to be sent round to the members.

Election of Officers.

Mr. James Smith was elected as President for the coming session, Mr. J. W. Frier as Senior Vice-President, and Mr. M. B. Herbst as Junior Vice-President.

Mr. J. A. Campbell and Mr. A. H. Tait were elected Members of Council, whilst Messrs. J. N. Simm, W. J. Paulin, F. Adam and C. Gresty were appointed Delegates to the General Council.

Mr. H. A. J. Rang was re-elected as honorary secretary, and, in thanking the members, said that he had now occupied that position for about 13 or 14 years, during which period he had always tried to do his best to advance the Branch. The next Convention was to be at Newcastle, and he realised that it would mean a great deal of work for everyone, himself included, but he promised to do his best to make it a success.

Mr. J. W. Frier (Senior Vice-President) and Mr. M. B. Herbst (Junior Vice-President) were appointed as Auditors, and Mr. W. J. Paulin as Treasurer for the coming session. These nominations were made in accordance with the new rules.

Mr. Young, in vacating the presidential chair in favour of Mr. Smith, said that, as this was Convention year, they wished to make the presidency a very great success for Mr. Smith. He, personally, would do everything in his power to help their new President, and he sincerely hoped that Mr. Smith would have a very good year of office.

Forthcoming Newcastle Conference.

Mr. Smith, in taking the chair, said he must first apologise for not having prepared a presidential address, the reason being that he had had no idea he was going to be appointed as their President. He greatly regretted that Mr. Wise was not able to preside during the coming year. He knew that they all appreciated the work which that gentleman had done for the Branch ever since he had become a member, and he was sure that Mr. Wise would have been a credit to the Branch during the Convention. Twelve months ago he never thought that he himself would be occupying the presidential chair during Convention year, and he wished to say that he had never sought the position. He had been a member of the Institute for about 19 years, and had refused presidencies many times. He had been asked about five times to act as President for the whole country, but had refused, not because he had not the Institute at heart, but because he always felt that there were better men than himself for the position. To-night, however, he had accepted the presidency, and he only hoped that in twelve months' time they would not have cause to regret having elected him. He knew that it was sure to be a very heavy year, but trusted that he would have the support of every member.

Mr. R. O. Patterson is to be elected the National President at the next Convention, he continued, and during his year of office he will need much help and sympathy, and it is for everyone to give him all the assistance they possibly can. He has been a good member of this Institute, and is worthy of the position he is going to hold.

He felt sure that the Newcastle Branch would see that the Convention at Newcastle was equal to any Convention that had ever been held. There was a Convention at Newcastle about 17 years ago, and at that time there were only about three local people who were members. All the local arrangements were made by another man and himself, and, considering that they had met with such success then, surely with a Branch of nearly 300 members they ought to make this coming Convention much more successful. He believed that some of the visitors were coming from America, so he hoped they would try to make it as pleasant as possible for them. Quite recently he had had the pleasure of meeting about 30 Americans, and the least he could say of them was that they were "jolly good fellows."

He sincerely hoped that everyone would put their shoulders to the wheel to make the Convention a success, and this would not only mean hard work, but money would have to be found somewhere, although he felt sure that, when the appeal was made, they would be able to raise sufficient money to make it a success.

Mr. Frier thanked the members for having elected him as their Senior Vice-President, and said that he was honoured to be able to sit next to Mr. Smith, who, though a foundry owner, was a practical foundryman, and he would be pleased to give him all the help he possibly could.

Mr. Weir said that he would like to propose that hearty thanks be given to their late President, Mr. Young, for the excellent manner in which he had carried out his year of office. He felt sure that Mr. Young had put his whole heart into the work of the Branch, and, notwithstanding the bad state of trade, he has carried out the work very successfully indeed.

Mr. Patterson seconded the vote of thanks, and said he thought that Mr. Young had had an excellent year.

Mr. Young, in replying to the vote of thanks, said that he had found his year of office rather difficult owing to inexperience, but his main wish that night was that the Convention should be a success. He was anxious to give all the help he possibly could, because he realised that this year was the important year and not last year. He sincerely hoped that the Newcastle Convention would be quite as good as, if not better than, any previous one.

The President hoped that there was a good year in front of them, but what he would like to see was an improvement in trade. Some people thought that the dole was making the working class lazy, but he believed that the British working man would do his bit if he could only get it to do. He knew that there were members of the Newcastle Branch who had suffered through the want of employment, and it was really splendid to see the way those men turned up to the meetings and took an interest in the Institute in spite of the fact that they were out of work. He thought that if the labour troubles could only be settled, something better would soon turn up.

Mr. Carmichael congratulated Mr. Smith on his succession to the chair, and said that he was just in the position he should have been in many years ago. He hoped their new President would have a very prosperous and successful year, and that the Newcastle Branch would benefit by their choice.

He was also very pleased that Mr. Herbst had been elected Junior Vice-President, and he wished him every success.

Mr. Gallon said, with regard to the Convention, that he felt sure everyone was very eager to help their President, and that Mr. Smith need only call upon any of them, himself included, to do any work that he thought they were able to do. He was sure they would all respond gladly and deem it an honour to serve him during the coming session.

BURNLEY SECTION.

The opening meeting of the Burnley Section was held on September 26 at the Municipal College, Burnley, the Section President, Mr. A. Hartley, in the chair.

In his introductory remarks, the Section President said he welcomed the members to this, the first meeting of the session, which he anticipated would give evidence of the progress of the Section. There were difficulties in the way of increasing membership, as throughout the country trade was bad, and the Burnley district had perhaps suffered even more than other districts in that respect. That affected them directly as individuals, and also as an association. Indirectly also the influence of such conditions must be prejudicial to a society which concerned itself with the technical advancement of the foundry industry. There were people who looked only to what would bring an immediate return, and were unwilling to engage in activities which they thought would yield nothing tangible to them, and that feeling was intensified by adverse industrial conditions. For that reason the Section was not getting as many members as it should, and as they would expect to get in more prosperous times.

Another matter of importance was the attendance at the meetings. The subjects to be discussed during the session ranged over the whole field of the foundry industry, and therefore individual members might on occasions think the lecture they had listened to did not enlighten them in the matters with which they were personally interested. A man whose business was the production of heavy castings might consider an address on light castings or upon core making was of little value for his particular needs. It would be a great mistake to allow such considerations to cause infrequent or irregular attendance at the meetings. No detail of his craft should be regarded by the foundryman as uninteresting or unimportant, and in every address and lecture there was something to be learnt which could be turned to good account in practice.

He then called upon Mr. J. Wood, of Wakefield, to deliver his lecture on Cupola Practice, which he said was previously given to the Lancashire Branch,* and gave rise to an interesting discussion.

Discussion.

Mr. Hogg asked how Mr. Wood would judge the quality of coke. Was there any simple method of ascertaining it, such as taking the percentage of ash, or anything of similar character? When iron and steel are being melted together, should the steel be placed next to the coke bed?

Mr. Wood replied that an opinion could be formed of the quality of coke by considering the density, the friability, and the porosity. A rough test was to drop it on an iron plate. But he knew no mechanical means of comparison beyond such rough tests as those. Usually the foundryman based his judgment on the quality of coke upon its appearance. In his own practice he dealt with fairly large quantities of steel, and always found that the best results were obtained with mixed iron and steel by placing the steel next to the coke bed. Pig-iron, melting first, assists the steel to melt, by a washing action.

Proportion of Limestone Necessary.

Mr. Pell said Mr. Wood might perhaps give some information as to the proportion of limestone which should be used. His own practice was to use about 28 lbs. of limestone to a 15-cwt. charge, and that agreed with Mr. Wood's statement that 40 lbs. of limestone to the ton was sufficient to give a good fluid slag. But would Mr. Wood approve of using extra limestone to flux rusty scrap iron?

Mr. Wood replied that oxide of iron was a flux in itself, but required limestone if sand is present.

The Chairman said he had always understood that when the blast had been shut off it was not possible to get the iron back to the condition in which it was previously: there was a certain amount of "dead" iron.

Mr. Wood said it had not been his experience of holding up the blast.

* See Foundry Trade Journal, vol. 25, page 288.

Life of C. I. Reinforcing Blocks.

The Chairman referred to the hollow iron blocks which Mr. Wood suggested should be used, being inserted about 3½ ft. above the melting zone, and carried to the top of the charging door. He had heard of the idea before, but had never seen it in actual practice. Perhaps Mr. Wood would state what his experience had been with them.

Mr. Wood stated that the blocks cost 1½d. each to mould, and would last a considerable time. With the exception of the lower two or three courses and those directly opposite the charging door, the blocks were very little worse at the end of twelve months' work, melting 50 tons every other day.

Tuyere Area and Blast Pressure.

Mr. Hargreaves observed that it was difficult to fix into an old-fashioned furnace a pair of tuyeres, when the furnace was without an air belt. Would the lecturer advise discarding them altogether?

Mr. Wood replied that a belt was essential, as it gave a better and more equal adjustment.

Replying to further questions Mr. Wood said the relation of the tuyere area to the cross sectional area of the cupola ranged from 15 to 25 per cent. It should not exceed the latter figure. In Paper he had described a cupola in which the ratio was as 1 to 6, the combined tuyere area being cent. It should not exceed the latter figure. In his a 24-in. cupola it might be 1 in 4. With regard to blast pressure he suggested with a 24-in. cupola, 6 ozs.: 30-in., 8 ozs.; 36-in., 10 ozs.: and 48-in., 12 ozs. Those were approximate figures; he could not lay down a hard and fast rule. The correct pressure should be ascertained by experiment.

Speed of Melting.

Mr. Pell asked how long it took to get the metal into the spout after the blast had been put on.

Mr. Wood said as a rule it was not more than 10 minutes before the metal started dropping, but in his practice it was necessary to wait until there was 20 cwt. in the cupola.

Mr. Pell said in the Burnley district the people who made textile castings were unable to wait until there was a ton of metal in the cupola, and it was a general rule the tap hole was left open when blowing was commenced. He had often timed the furnace, and the time of getting the metal varied from 11 to 15 minutes. On certain days they could not get the speed which was possible on other days. When metal came down in 11 minutes the runnings dropped out, the hole stopped up and in a few minutes afterwards the moulders started to take out the metal. They could take it away as quickly as it melted: sometimes the metal came too fast, especially if they were on a smaller furnace than usual. Another point he would like Mr. Wood to deal with was the distinction between beehive coke and by-product coke. Did he think one was better than the other?

Beehive and By-Product Coke.

Mr. Wood said they used both kinds, and he could not see that there was any difference in the operation. Beehive coke had a silvery grey appearance, whereas the by-product coke was usually black and dirty-looking, but nevertheless one seemed to get the same value out of it.

Mr. Pell remarked that if such was the case beehive ovens could be scrapped and money made out of the by-products. But most of the foundries in the Burnley district preferred the beehive coke.

Mr. Wood: Perhaps the reason is that coke makers are conservative and like to cling to old ideas. Also it is rather an expensive job to put up the plant necessary to get the by-product coke.

Mr. Pell said on the other hand people were going to the expense of rebuilding beehive ovens or putting up new ones. It seemed to him one could reasonably expect to get better results out of beehive coke, because there must be some advantage from the by-products which were left in it.

In proposing a vote of thanks Mr. Hogg said the Paper was based upon actual experience, and its value was considerably enhanced by that fact.

The vote of thanks was carried with acclamation, to which Mr. Wood briefly replied.

Eustis Electrolytic Iron-making Process.*

After research over a period of four years, pure iron is being made by electrolysis from iron ore at the plant of the Milford Electrolytic Iron Company, Milford, Conn. The process may open up to exploitation large deposits of iron ore of a character unsuited to blast-furnace reduction, and add greatly to the world's potential iron-making capacity. Although electrolytic production of iron dates back as far as 1486, it is only within the last few years that the method has proved a commercial success. The Société le Fer, Grenoble, France, was a pioneer in applying the method on a tonnage scale. It took out its first patents in 1910, and since 1915 has been producing pure iron tubes on a commercial scale.

While intended only as a pilot plant to furnish the experience that will serve as the basis for the erection of plants at more favourably located points, the Milford establishment is equipped to dissolve 2½ tons of ore per day. Owing to the continuance of experimental work, both with respect to the design and construction of equipment and testing various kinds of ores, present operations are at the rate of half a ton of ore per day. Iron produced by the Eustis process averages over 99.9 per cent. purity. Its only serious impurity, hydrogen, which is deposited along with the iron, is easily eliminated by annealing. The resulting product is as soft as copper and aluminium and has greater ductility and cold-working ability than either of these metals. In fact, because pure iron has been available only in the last few years, it is only recently that the merits of this product have been thoroughly understood. The pure iron is extremely ductile and becomes harder and stronger with cold-working, but the hardness does not exceed a certain point. In cold-working it is not necessary to anneal pure iron nearly as often as iron and steel of the usual quality. In drawing pure iron wire a reduction of area of more than 98 per cent. is obtained without annealing. It is found that the ability to work pure iron without annealing constitutes a great saving in cost as compared with the cost of working ordinary steel. Because of its great ductility and its unusual cold-working properties, pure iron is particularly suitable for deep stamping, cold rolling and drawing. Another big field is that of pure-iron boiler and other thin tubes, which, by the use of revolving cylindrical mandrels can be made as a finished product in the electrolytic cells. It is expected that the alloy-steel field will furnish a considerable outlet for electrolytic iron, since its use assures purity of the ferrous content. The magnetic, resistance and tensile qualities of pure iron have attracted the attention of large manufacturers of telephones, cables and electrical apparatus.

Calculations of the cost of producing iron by the Eustis process are modified by allowances for the market value of by-products. Pyrite was the chief source of the world's sulphur until the development of the Louisiana deposits made it a losing proposition to obtain sulphur from pyrite.† By the new process, however, the sulphur content of the ore assumes such importance that the sulphur obtained practically pays for the ore. On the average, a ton of sulphur is produced for each ton of iron. Deducting the value of the sulphur, the Milford Company estimates that the cost of producing electrolytic iron will range from $50 to $60 a net ton of finished tubes or sheets under ordinary conditions, and that where the conditions are ideal, the cost will be less. These cost figures are subject to further reduction where the ore bears reclaimable copper, gold, silver, and other elements.

Eustis Process.

Ferrous chloride is the electrolyte in the Eustis process. The first unit in the leach house is an agitator in which ore, ground to a fineness of about 200 mesh, meets ferric chloride and is dissolved, the solution thus being reduced to ferrous chloride. The overflow from the agitator goes to a settling tank or thickener which has two products, a clean overflow and a bottom sludge. The overflow from the settling tank goes to a cementation tank filled with scrap iron on which the copper contained in the solution is precipitated. The solution then flows to the storage tank which feeds the electrolytic cells. In the cells iron is deposited, the overflow from the cells being ferric chloride. The latter is fed to a second thickener where it meets the sludge from the thickener and dissolves out of the sludge the remaining iron, thus producing a clean tailing product. From the second agitator the solution flows to a second settling tank and thence to the first agitator, where it again is fully converted into ferrous chloride. The tailings are removed from the second thickener and the sulphur recovered from them by distillation.

A considerable tonnage has been produced in the form of plates and construction of two improved plate cells has been completed. Each cell has about 80 sq. ft. of cathode surface, the output for each being 20 plates, each 2 ft. sq. In the tube cells, the mandrels are rotated by means of belts which engage a pulley on the outside of the cells, thus insuring a smooth deposit. In the leach house as well as in the cell department the construction largely is of wood. It has been ascertained, however, that the best material for a permanent commercial plant is concrete soaked in sulphur by the method developed by the Texas-Gulf Sulphur Company, and one tank of this material already has been constructed and has given entirely successful results. In all of the cells the anode and cathode compartments are separated by asbestos sheets through which the electrolyte seeps slowly from the cathode into the anode compartment. In order to maintain proper circulation, the flow is so controlled as to maintain the solution at a higher level in the cathode than in the anode compartment.

For handling pyrite ore, the plant is equipped with a gas-fired furnace, the ore being brought to a temperature of about 480 deg. C., in order to drive off the excess sulphur. The sulphur is given off as a gas which is converted into liquid form in a condenser. The pyrite thus is changed to ferrous sulphide which is ready to be charged into the first agitator in the leach house. The remaining sulphur, as previously stated, is reclaimed from the tailings obtained from the second agitator.

Power Consumption.

Consumption of current is about one ampere hour per gramme of iron deposited. The speed of deposition may be controlled at will and is determined by the relation of the cost of the power to the capital charges and also, within limits, by the quality of surface desired. For instance, the plate cells may be operated with 2,000 to 4,000 amperes. By the smaller current an output of 20 plates, each 2 × 2 ft. and ⅛ in. thick is obtained in 96 hours, and the surfaces of the plates are relatively smooth. Also with the slower current less power is consumed. With 4,000 amperes the same output is obtained in 48 hours, but the surfaces of the plates are less smooth. A larger plant, entailing a larger investment, is necessary when using the slower current so that the speed of driving the cells is a matter that must be determined carefully. Generally speaking, it is of course desirable to distribute the overhead cost over as large a tonnage output as is feasible.

Application of the Eustis process necessarily is dependent upon the availability of cheap electric power. At $20 per horsepower per annum, *i.e.*, $26.8 per kw. per annum, the cost for power per ton of iron, provided the plant operates 90 per cent. of the time, would be $4.90. Current efficiency in the new process is high. It always is above 85 per cent., but averages close to 95 per cent. and on occasions has been 97 per cent. of the theoretical performance. An important feature of the electrolytic process is that it will permit the creation of self-contained, complete industries in countries and sections where the materials which are necessary for the production of iron by the blast-furnace method, do not occur in juxtaposition.

* E. C. Kreutzberg in the "IRON TRADE REVIEW."

† This presumably refers to American conditions. Pyrites is still and is likely to remain the chief source of our sulphur supplies.

THE IMPORTS OF FOREIGN IRON ORE at the Senhouse dock at Maryport during last month amounted to 9,000 tons, compared with 10,500 tons for August and 12,000 tons at the corresponding period of last year.

An Apprenticeship Course in Foundry Practice.—LXI.

By Ben Shaw and James Edgar.

STEEL FURNACES.—Part II.

Converters.

It would be extremely unwise, with regard to melting processes, to state without qualification that one method is superior to all the others. Production costs and quantities have to be considered as well as quality. In point of quality, crucible steel takes first place, closely followed by electric steel, but, in small foundries, or foundries which specialise in small castings, while the crucible or electric furnaces might serve well, they might not be a sound business proposition, and the converter process, in one form or another, is employed. There are many steel foundries in the country which are producing work with converters very little inferior to the electric-furnace metal.

In the converter process the metal is first melted in a cupola which does not differ in principle from the cupola of the iron foundry. In some instances, notably the Stock converter, the melting is done in the converter; these are, however, exceptions to the usual method, and we will refer to this type presently. The cupola is charged with pig-iron, with or without steel scrap, the pig-iron having a low-sulphur and phosphorus content because the process is invariably acid. After the charge has been melted in the cupola it is conveyed to the converter. Frequently the cupola and converter are so arranged that when the cupola is tapped, the fluid metal runs direct into the converter. The converter may be described as a cylindrical steel vessel tapered towards the top and lined with a highly refractory material. The principle of the process of converting the molten metal into steel is the oxidation of the carbon, silicon and manganese in the iron. This is done by blowing a stream of air either through or against the metal. When the air is passed through or against the metal, reactions take place, the oxygen of the air combines with silicon to form silica, with carbon to form carbonic oxide, with manganese to form oxide of manganese, and, if overblown, with iron to form oxide of iron. When a rapid combination is made, great heat is produced; on the other hand, if the combination is slow, the heat is relatively small. The success of this process, therefore, depends upon the rapid production of heat by the combination of the oxygen in the air and the impure elements in the iron. During the first stage of the blow the silicon and the manganese are the first to combine with the oxygen, and the silica and oxide of manganese are present in the slag which is formed as a result of the oxidation. At this stage very little carbon is burnt out, but the temperature of the metal has increased considerably owing to the effect of the oxidation of the other elements. As the heat increases, the combustion of the silicon becomes more rapid, and the temperature of the metal is further increased. It is during this stage, known as the second stage, that the carbon is attacked, producing carbon monoxide, which is burned and converted into carbon dioxide at the top or nose of the converter. The escape of the carbon monoxide sets up a violent commotion in the converter, which causes the metal to boil. Gradually this ebullition of the metal subsides, as the carbon content is reduced, and the flame, which has been rising from the nose, dies down until there is not sufficient carbon monoxide being produced to support it. When the flame finally drops, decarburation is said to be complete. It is at this stage that ferro-silicon and ferro-manganese or spiegeleisen is introduced to recarburise the metal, the amounts added depending upon the qualities desired. It must be remembered that there is no alteration in the amount of phosphorus originally in the charge when an acid-lined converter is used, whilst with the basic converter the phosphorus is not removed until after the flame has dropped, during the "after blow." This process is not suited to small converters.

There are several types of converters operating on the same principle, but differing in design. In the ordinary Bessemer converter (Fig. 1) the air enters from a box through bottom tuyeres, while in a Tropenas converter (Fig. 2) the tuyeres are at the side, and the air is blown on the surface of the metal. The object in each case is the same. Fig. 1 illustrates a concentric-nosed converter, and Fig. 2 an eccentric-nosed converter. With the Bessemer converter the air pressure varies from 20 to 30 lbs. per sq. in., according to the depth of the charge. There is a limit to the volume of air that can be admitted to the converter; when the volume is too great the chemical action is extremely violent, and cuts into the lining of the converter very rapidly. The pressure is therefore varied to suit the condition

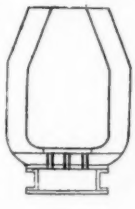


Fig. 1.

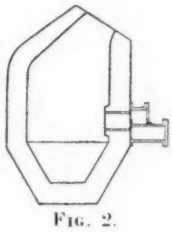


Fig. 2.

of the lining, the number of tuyeres, and the head of metal in the charge. On the other hand, side-blown converters, like the Tropenas, or Robert or Clapp-Griffiths, do not need the high air pressure of the bottom-blown converter, 3 lbs. per sq. in. being sufficient. Bessemer converters are usually of large capacity, and consequently are not suitable for small foundries. In such cases, small converters are used, and these are invariably side blown. More perfect combustion is associated with the small converters than with the Bessemer converters, and this condition ensures a hotter metal; but this involves a greater loss of metal through oxidation.

With regard to the handling of converters, there is no standard method of tilting. Trunnions—which are not shown on the sketches—are necessary, and either hand- or power-operated gear is used to tilt to any angle. The first operation when charging a converter is to kindle a coke fire inside it and bring the lining to a bright red heat, after which it must be thoroughly cleaned out by turning it bottom up, and blowing out any ashes that remain. The Tropenas converter, as will be seen by Fig. 2, has two rows of tuyeres close together, the top row being rectangular, and termed combustion tuyeres, while the bottom row are circular, and termed reaction tuyeres. The usual lining—acid—is silica or ganister. In charging a converter it is tilted over to a horizontal position and the metal poured in either direct from the cupola or from ladles. When the metal is almost up to the tuyeres, the capacity of the converter has been reached. The blast is then turned on and the converter brought to a vertical position. The decarburation is complete when, as already explained, the flame at the nose dies down. In charging the Tropenas converter it is first tilted to a convenient angle, and, when the molten metal has been poured, it is brought back towards a vertical position until the metal is level with the bottom row of tuyeres when the blast is turned on. The Tropenas converter process approximates very closely to the open-hearth process, because oxidation is effected in both cases by a surface current of air, aided by ore additions in the latter process. The former, however, can be tilted so that the air pressure can be blown through the charge, or partly through the metal and partly over the surface. This gives a sufficient supply of free air to ensure combustion inside

the converter, giving heat that is practically lost in the Bessemer converter, where the combustion occurs at the nose.

The Stock Converter.

The Stock oil-fired converter differs considerably from these converters already described. It is both a melting and a converting apparatus, thus the cupola is dispensed with. This type of converter possesses many advantages, and is particularly suitable for foundries making steel castings only. The points in its favour are: (1) Practically no impurities are introduced into the metal from the fuel; (2) the heat can be maintained indefinitely; (3) the finished metal can be poured very hot, therefore it is suitable for the production of high-class thin and accurate work; (4) the waste gases from the converter during the time of melting pass to the flue through an economiser, consisting of a series of pipes, through which passes the air required for the blow. The air is thus preheated to a temperature of about 400 deg. C.; (5) by comparison with other steel melting furnaces the Stock converter takes up little space.

These converters are usually lined with silica bricks or special granular silicious refractory material, and therefore an iron low in phosphorus should be used. To operate the converter it is first turned into a horizontal position for charging. The oil and blast are turned on to bring the lining of the furnace to a white heat, the oil being ignited by means of lighted waste. When the lining is hot enough the blast is shut off and the charge introduced. Resting on bars on the face of the furnace is a bar which supports the peel used for charging. The pig and scrap are laid on the peel and pushed into the furnace. The arrangement of the charge should be such that it protects the lining from the flame, and the scrap should be placed at the back where it gets the full heat of the flame, as it melts at a higher temperature than the pig-iron. The furnace is slightly tilted until the nose is opposite the uptake to the economiser. The oil and blast can then be turned on to commence the heat, the time of melting being about 1½ hours, with a blast pressure of about 12 ozs. per sq. in. When the charge is melted the blast and oil are turned off, the oil burner removed and the furnace turned into a vertical position for converting the metal. The blast for this purpose is increased in pressure to between 3 and 4 lbs. per sq. in. When the flame drops, an operation that occupies about 20 mins., the converter is tilted into its charging position, and the metal is recarburised by adding ferro-manganese or pig-iron. After a ferro-silicon addition the metal can be teemed into ladles.

Open-Hearth Process.

The open-hearth process is that employed in foundries, where very large castings are produced, because the limit of the size of these funaces is very high. The capacities of these furnaces range from 5 tons to 100 tons, but furnaces of the latter capacity are few, and a 50-ton furnace may be considered as being a large furnace. This is the cheapest method of producing steel. No air blast is used as the metalloids are removed by surface oxidation caused by an intensely hot flame passing across the surface of the molten metal, together with iron ore additions. A special gas-producing plant is an integral part of the furnace as the oxidising flame is produced from a mixture of gas and air. It has been described how the rapid oxidation of manganese, silicon and carbon, in the Bessemer process, not only maintains the charge in a molten condition, but raises the temperature above the melting point of steel. It is by blowing air through the steel that this rapid oxidation is effected. Under ordinary conditions the maintenance of such a high temperature in the open-hearth furnace is not practicable. This difficulty is, however, overcome in the Siemens furnace by making use of gas as fuel and introducing the principle of regeneration. By means of regeneration the waste heat of the furnace is used to heat the air and gas before they enter the furnace. In this way both the air and gas are raised to a high temperature before they enter the furnace, and this materially affects the intensity of the flame. The method employed in heating the gas and air, in the ordinary Siemens furnace, is by passing each through separate chambers built of refractory bricks so arranged that the surface area exposed is considerable. To obtain this the bricks are chequered. Two pairs of chambers or chequers are used, and they are under control so that air and gas are introduced from one pair at a time, the waste gases passing through the opposite chambers, give off considerable heat which is absorbed by the chequer-brickwork. After an interval of about 20 mins. the process is reversed by operating the valve shutting off the air and gas from one side and introducing them from the other. The method can be followed more readily by reference to Fig. 3, which shows a section of a Siemens furnace. The regenerating chambers A and B are for air, while those marked C and D are for gas. On the left of the illustration, at E, is shown one of the air ports, and on the other side, at F, is shown one of the gas ports.

There are two modifications of the ordinary Siemens furnace; one in which the gas producer and furnace are combined and which has air regenerating chambers only, the gas being supplied direct from the producer; the other is a tilting furnace in which the furnace is supported on rollers or rockers on which it can be tilted to remove slag and to pour the metal through a notch above the working level of the furnace. Although there are many different kinds of open-hearth furnaces, it is only constructive details that differ, the prin-

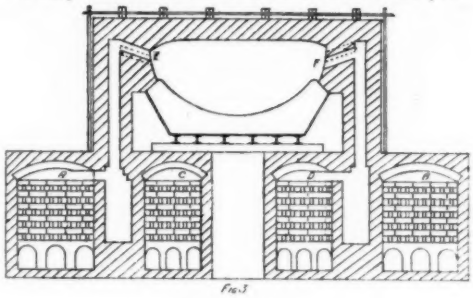


Fig. 3.

ciples of the process do not vary. As with other types of steel furnaces and converters both the acid and basic processes are used with the open-hearth furnace. The bed of the acid furnace is prepared to form a solid and well-fritted surface before the charge is made. This is done by fusing silica sand over the bottom against which the metal will come in contact. To effect this the temperature must be raised to about the melting point of steel. In some cases sandstone chippings are spread over the bottom, and as these melt with the heat silica sand is spread over and allowed to fuse, forming a hard, glazed surface on the bottom lining of the furnace. When the first layer of sand has become glazed satisfactorily more sand is spread over and the process repeated until the required thickness of bottom lining is obtained. It is important that successive layers of sand should be well fused together.

Acid furnaces do not affect the sulphur and phosphorus contents of a charge so that the basic process must be used when it is necessary to reduce the content of this element. The construction of the basic open-hearth furnace does not differ from that involving the acid process, but the bottom must be made up of a basic or neutral material. Invariably magnesite bricks are built up to form the bottom and banks, though it is preferable to use ordinary firebricks being cheaper in contact with the outer shell of the furnace before introducing the magnesite bricks. The magnesite bricks are carried up the sides to a height of about two rows above the working surface of the furnace, or two rows above the tap hole if a tilting furnace, the remainder of the sides and the roof being built of silica bricks. Thus in a basic furnace only that part of the furnace against which the metal is likely to come in contact is composed of a basic material, the remainder being an acid material, and, as a fluxing action occurs at the junction of these basic and acid materials at high temperatures, some neutral agent must be used between magnesite and silicious bricks. For this purpose it is customary

to interpose a row of chrome bricks or a layer of chrome ore mixed with tar to give a similar consistency to that of stiff loam. The lining of the hearth is fused on in a manner similar to that for an acid hearth, but dolomite is generally used as the basic material. The method of making up the hearth consists, in the first place, in raising the temperature of the furnace and scattering over the magnesite bricks some finely ground basic slag. As the heat in the furnace is increased the slag begins to flow, this forms a bond for the bricks. Calcined dolomite is then scattered over the hearth and this is allowed to become thoroughly hard when more dolomite is scattered over the surface. Subsequent coatings of dolomite are given but not until the preceeding one has been properly fused. When the lining is of the required shape and thickness more basic slag is spread over the bottom which, when fluid, will fill any small openings in the dolomite that have not fused together, this gives the lining of the furnace a smooth surface.

The charge usually made in a basic hearth furnace consists of steel and hematite cast-iron scrap, pir-iron, lime or limestone. The proportions, of course very according to the quality of the steel required, and with the working conditions of the furnace. The quantity of lime and mill scale or ore that is used during the milling of a charge depends upon the composition of the charge. As a rule the charge of scrap steel should not exceed 30 per cent. of the whole, and for every ton of hematite iron scrap and pig-iron, 3 cwts. of limestone should be used. When lime is used the quantity will of course be less. When the percentage of pig-iron is high, a relatively greater quantity of ore or mill scale is necessary to assist in eliminating the impurities. As much as 3 cwts. per ton of pig-iron may be required, but the amount is variable and depends upon the character and quantity of impurities that require to be removed. This is best determined by the appearance of both the metal and slag during the working of the furnace. Samples of the metal are taken at intervals to test it. In the basic process, when the phosphorus is too high, compared with the carbon, then lime is added; on the other hand, if carbon is too high, mill scale needs to be added. The quality of steel produced depends largely upon the skill of the melter. He endeavours to work the furnace so that the carbon is not removed before the phosphorus otherwise the metal will go off the boil and it is only with difficulty that the phosphorus can then be removed.

Re-carburising is usually effected by the addition of pig-iron and ferro-manganese in the furnace and ferro-silicon to the ladle while the furnace is being tapped, especially in the basic process, as its combustion may make the slag acid and give rise to the possibility of phosphorus passing back from the slag to the metal. To free the steel from occluded gases aluminium is used. The amount used rarely exceeds about 7 ozs. to the ton of metal, and this quantity only when the steel is badly oxidised. It is usually added to the ladle while the metal is being tapped from the furnace.

The usual type of ladle for steel consists of steel plating lined with firebricks, the internal lining being frequently made up with a ganister "compo." The metal is not poured into moulds by canting the ladle, but is released from the bottom by operating a nozzle from the side of the ladle.

T. G. Bell & Company, Limited, wagon owners and contractors, 21 and 22, Bardon Chambers, King Street, Leeds, have acquired works at Finningley, near Doncaster, for the purpose of building and repairing wagons.

Hawthornes & Company, Limited, of Leith, have secured a contract from the Leith Dock Commissioners for the construction of two non-propelling hopper barges. The vessels will be 130 ft. long, and each will be fitted with two powerful steam winches for operating the hopper doors.

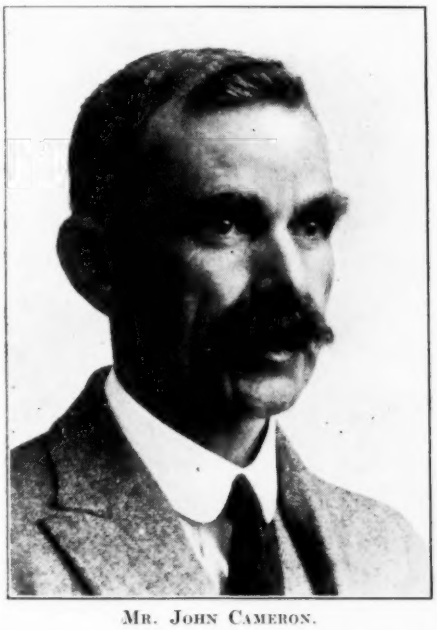
A British engineering firm has submitted an offer to the Latvian Ministry of Finance to supply on credit to Latvian farmers threshing machines and other agricultural machinery and tools. The conditions are: 25 per cent. of the invoice to be paid on receipt of the goods and the remainder within three or four years.

"Mould ers" of the Industry.—No. 17

Mr. John Cameron.

Mr. John Cameron is managing director of Messrs. Cameron & Robertson, Limited, of Kirkintilloch, near Glasgow, and also a director of the Eastern Light Castings Company, Limited, of Bengal, India. He is the elder son of the late Mr. John Cameron, and became the sole proprietor of his firm in 1890, and remained so until the concern became a private limited company in 1899.

Mr. Cameron joined the Institute of British Foundrymen in 1917, and the following year



Mr. John Cameron.

represented the Scottish Branch on the General Council. That his services were appreciated is shown by the fact that he was elected a member of Council in 1921. He is also a member of the Council of the British Cast Iron Research Association. Mr. Cameron has made a special study of semi-steel, and has read Papers on this subject at Glasgow, Falkirk, Sheffield, and before the 1922 Birmingham Convention.

He is also identified with the British Engineering Standards Association, where he serves on sub-committees dealing with Smoke, Hot-Water, Soil and Ventilating Pipes.

Mr. Cameron has travelled very extensively in India and Russia.

Contracts Open.

Great Yarmouth, October 20.—Sectional cast-iron tank, 5 ft. square by 5 ft. deep, for the Guardians. Mr. W. Carter, clerk, 11, Queen Street, Great Yarmouth.

Fremantle, Australia.—(a) 30-in. and 36-in. diameter steel pipes f.o.r. Fremantle (Contract 402) and (b) 16-in. diameter 3-16-in. metal, steel pipes, f.o.r. Fremantle (Contract No. 405), for the Government of Western Australia. The Department of Overseas Trade.

Northwood, I.W., October 17.—Supplying and laying about 924 yards of 3-in. cast-iron water main, for the Isle of Wight Rural District Council. Mr. R. Jolliffe, chartered surveyor, Cowes, I.W.

Stourbridge.—Nine tons of 3-in. cast-iron pipes, for the Stourbridge and District Water Board. Mr. W. B. Cleverly, engineer and manager, Hagley Road, Stourbridge.

Copenhagen, October 23.—Telescopic gas reservoir, for the Eastern Gasworks of Copenhagen. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

XUM

Belt Driving Principles.

By J. A. Cormack, B.Sc.

Although the transmission of power by belting is so familiar, and enters so largely into the organisation of practically every factory, the principles involved in connection with it are inadequately appreciated and are, in consequence, frequently transgressed. In belt-driving it is not practicable to coil the belt round the pulley, and in most cases the arc of contact offers little possibility of increase. It is, therefore, necessary to inquire carefully into the nature and law of this method of transmission, so that any modifications made may be in the direction of improved capacity and efficiency.

The relationship between the tensions in a belt when on the point of slipping is expressed by the equation

$$\frac{T}{t} = e^{\mu\theta} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where **T** is the tension in the tight side of the belt.
t is the tension in the slack side of the belt.
e is the base of the Naperian system of logarithms.
μ is the coefficient of friction between belt and pulley.
θ is the angle of contact of belt, in circular measure.

$$(i.e., \theta = \frac{\text{Arc ABC}}{\text{radius OA}}) \text{ See Fig. 1.}$$

The effective force **P** transmissible from the belt to the pulley, or *vice versâ*, is expressed as:—

$$P = T - t.$$
$$= t\,(e^{\mu\theta} - 1) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

The forces **T** and **P**, therefore, depend solely upon the initial tension t, the coefficient of friction μ, and the arc of contact θ.

Now it is the case that equations (1) and (2) represent the law of true compound interest, of which, therefore, belt-driving is an excellent example. The initial capital is represented by the initial tension t, the rate of interest by the coefficient of friction μ and the total period of accumulation by the arc of contact θ. The accumulated sum is equivalent to the final tension **T**, and the total interest by the difference between the tensions $T - t$ or **P**.

In order to visualise the compound interest growth of the tension from t to **T** the diagram, Fig. 2, has been drawn, and taking t as unity, this shows the values of **T** and **P** corresponding to the values of 0.3 and 0.4 for μ. Table I gives the actual figures on which the curves are based:—

Table I showing values of T.

Arc of contact		Value of T at point of of slipping when t = 1.	
In circular measure.	In degrees.	$\mu = 0.3$	$\mu = 0.4$.
0	0	1.000	1.000
0.35	20	1.110	1.150
0.70	40	1.233	1.322
1.05	60	1.369	1.520
1.40	80	1.520	1.748
1.75	100	1.6 8	2.010
2.09	120	1.874	2.311
2.44	140	2.081	2.65
2.44	140	2.081	2.658
2.79	160	2.311	3.056
3.14	180	2.566	3.514
3.49	200	2.850	4.040

The curves show more clearly than the table how the interest, or the effective force **P**, increases more and more rapidly the longer it is left to accumulate. When the coefficient of friction is 0.3, **A N E K** is the curve obtained, and **T** is respectively **L N**, **C E**, and **H K** at 60 deg., 120 deg., and 180 deg., while **P** is similarly represented by **M N**, **D E**, and **B K**. When μ is 0.4 the curve is **A N′ E′ K′**, and **T** and **P** are represented by **L N′**, **C E′**, and **H K′**, and by **M N′**, **D E′**, and **B K′**. At 180 deg., by increasing μ from 0.3 to 0.4, **P** increases (in round figures) in the ratio of 3 to 5, and the importance of these curves lies in their showing the rapid increase of **P**, due both to greater arc of contact and to increased coefficient of friction.

Considering the matter either as one of compound interest or in terms of the essential quantities in belt-driving, the aims to be kept in view in laying out a new installation or in correcting a faulty one are:—

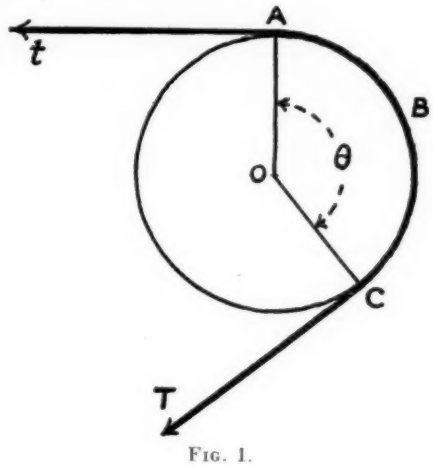


Fig. 1.

(1) Let the capital invested or the initial tension in the belt be a minimum. The use of a wider belt has no effect on the issue except that it gives an opportunity for excessive tensions to be employed, thus needlessly overloading the shafting. A belt unnecessarily heavy increases the power wasted in bending and unbending the belt as it runs on and off the pulleys, and it would be

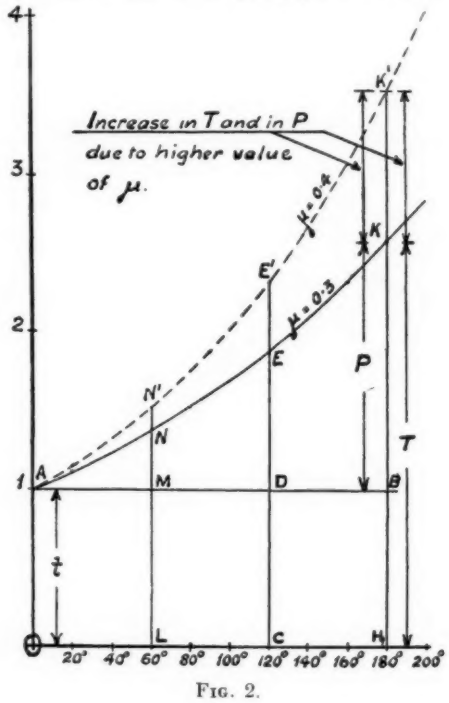


Fig. 2.

well if the engineer regarded the lightest possible belt as his ideal. The greater resistance to bending in the belt reduces its effective pressure on the pulley.

(2) The rate of interest should obviously be as high as can be obtained, and therefore a high coefficient of friction should be aimed at. The coefficient for leather and steel is about 0.3, but if the belt is greasy or oily, or has gathered dust, it is likely to be as low as 0.2. The belt is capable of a higher adhesion, and as it is the pulley that limits the friction by offering no suitable grip-surface, it is clear that real improvement lies not in tampering with the belt, but in giving the pulley such a surface as will enable each fibre to

obtain a lodgment and thus to do its share of the work.

(3) The value of the time-money is left to accumulate, and the equal value of a large arc of contact will be quite clear. While crossed belts are not to be recommended, it should be kept in mind that with open belts the arc of contact on the smaller pulley is less than on the larger one. Hence a difficulty generally occurs at the smaller one, where also the loss in bending the belt is greater.

(4) It would be natural in matters of compound interest to operate on the larger rather than on the smaller scale, and in belt-driving this is expressed by using large rather than small pulleys. A pair of pulleys 18 in. and 24 in., replacing a pair 12 in. and 16 in., with the same t, μ, and θ, give the same P; but because the speed of the belt and of P is greater, the latter is able to develop greater power. There is less loss in flexing the belt on the larger pulleys, but the belt speed should not be unduly high, as centrifugal tension interferes with its transmission power. At 3,000 ft. per min. the centrifugal tension is about 31 lbs. per sq. in. in a leather belt.

(5) Unnecessarily wide and heavy belts and unduly high tensions represent merely the squandering of capital—the more so as the belts cost more, and the wear and tear and lubrication of bearings, etc., are fairly heavy charges on income.

Steam Jet Furnace Developments.

By David Brownlie, B.Sc.

The steam-jet forced-draught furnace for boiler working, especially for smaller hand-fired boilers, whether of the "Lancashire," "Cornish," "Locomotive" or "Vertical" type, has a number of very considerable advantages. These may be summed up as intense local heat resulting in low exit-flue gas temperature, draught under perfect control by merely adjusting a steam-supply valve, easy burning of inferior and especially clinkering coals, easier cleaning out because the ash tends to be granular, the life of the fire bars is very many years because of the cooling and protective influence of the steam, ease of installing and working, together with simplicity of design and low first cost.

It is very necessary however, to have a correct design to obtain the best result with a stem-jet furnace, and because of the absence of this in most types on the market, two of the inherent defects are the excessive consumption of steam at the nozzles and the unequal pressure of the air blast at different points of the grate, both longitudinally and transversely. Some tests just carried out by the staff of a large steelworks on the working of the "Turbine" furnace are of great interest in this connection, as for the first time some really unprejudiced and accurate data on these points is obtainable, and the above defects are proved to be due to defective design.

The result of the tests in the first place is that the steam consumption of the nozzles is 3 per cent. the production of the plant, practically only equal to mechanical draught, whilst having, of course, the advantage—already mentioned—of many years' life for the fire bars, instead of the usual twelve months. Also the curve of the intensity of the air blast at every stage of the bar length was found to be a dead straight line, a remarkable tribute to the efficiency of the "Turbine" design, which is based on the principle of the "De Laval" steam turbine. Most steam-jet furnaces tested in this way are found to give actually a suction for about the first 2 ft. of the grate length and a great increase of pressure at the back, whilst also the sides are obtaining much more air than the middle.

The "Turbine" furnace (Messrs. The Turbine Furnace Company, Limited, 238B, Gray's Inn Road, London, W.C.1) has now been adapted to work with vertical boilers, even of the smallest size, and it has also been proved by the Vancouver Ferry Board to be very suitable for marine conditions.

Finally, a very important new modification of the "Turbine" furnace is claimed to have solved the problem of burning fine refuse anthracite coal, which would represent a revolution in districts such as South Wales, with abundant waste anthracite. As is well known, anthracite is always difficult to ignite, but when in the dust form, "culm" or "duff," it has hitherto proved an almost hopeless proposition. Thus the fine dust chokes the draught, and in spite of this the bars have to be very close together, or else the material falls through. Also, if mechanical draught is used, the only result is to blow the fuel off the bars unburnt because it is so light.

The modification of the "Turbine" furnace devised for this purpose is to substitute the small ⅛-in. air slits between the small bars or "elements" in the standard design with a row of very tiny holes or slots, so that the grate surface of a "Lancashire" boiler 30 ft. by 8 ft. contains a number of thousands of these slots. The result is the draught is so sub-divided that a proper forced blast does not blow the material off the bars, and standard "Lancashire" boilers are now working in South Wales evaporating over 5,000 lbs. of water per hour with anthracite refuse fuel only, the importance of which can hardly be exaggerated. It has now, in fact, been decided to adopt this "slot" element as the standard, and to use the present ½-in. slit element only for high volatile fuels.

Repairing Furnace Bottoms.

The Trumbull Steel Company, Warren, Ohio, is employing a novel labour-saving device in repairing the bottoms of open-hearth furnaces. It is operated by means of compressed air and a small electric motor. It conveys refractory material, ¾ in. and under in size, from a steel tank through a 2½-in. hose and nozzle into the furnace, and is sufficiently flexible to repair slag lines along the back wall, port ends and front wall, the latter being reached by use of a curved nozzle.

The tank has a capacity of 13,000 lbs. of refractory material, which can be discharged at the rate of 500 lbs. to 1,500 lbs. per minute. The machine is placed in front of the furnace by the overhead crane serving the charging floor of the furnace department. The floor is provided with the necessary air and power connections and the setting up of the machine preparatory to use is a matter of a few minutes. At the Trumbull Steel Company's plant, the average time between tapping and charging has been cut down from one hour to 30 min. since this plant was introduced. Frequently the elapsed time is less than 15 min. In a plant in the Pittsburgh district having furnaces of like capacity to those at Warren, Ohio, it takes seven men slightly over 30 min. to make the necessary refractory repairs after each heat. They shovel in about 13,000 lbs. of refractory material, including 4,000 lbs. of burned and 9,000 lbs. of raw dolomite. The same work at the Trumbull steel plant, under corresponding furnace conditions, is completed in less than 10 min. with the machine.

Where the making of bottoms is a manual operation, it is usually necessary to raise two of the furnace doors simultaneously; with the machine only one door is opened and that just enough to permit the insertion of the nozzle and to enable the operator to see what he is doing. This permits a considerable conservation of heat and protects the furnace walls and roof from sudden changes in temperature. The front wall slag line is rebuilt while the steel is going into the ladle. None of the crew engaged in bottom-making is exposed to direct heat for more than five minutes.

The Works and Stores Sub-Committee of the Glasgow Corporation have recommended that contracts for two sets of turbo alternators and condensing plant for the Dalmarnock Power Station be given to C. A. Parsons & Company, Limited, Wallsend. It is estimated that each set will cost £90,000. The sub-committee also recommended acceptance of the offer of Reyrolle & Company, Limited, Gateshead, to supply high-tension switch gear for the same station at an estimated cost of £34,000.

Trade Talk.

PRITT & COMPANY, metal merchants, have removed to 21, Mincing Lane, E.C.3.

THE LONDON OFFICE of the Sheepbridge Coal & Iron Company, Limited, has been removed from 53 to 7, Victoria Street, Westminster, S.W.1.

KORTING BROTHERS (1917), LIMITED, engineers, have removed from 27, Shaftesbury Avenue, W.1, to 64, Victoria Street, Westminster, London, S.W.1.

T. H. MORGAN & COMPANY, iron and steel merchants, etc., have removed from 66, Finsbury Pavement, E.C.2, to 60, Queen Victoria Street, London, E.C.4.

THE WAGES regulated by the Sliding Scale under the Midland Iron and Steel Wages Board will remain unaltered from Monday, October 8, to Saturday, December 1.

MR. JOHN W. HALL, consulting engineer, has removed from 71, Temple Row, Birmingham, to more commodious offices at Quality House, 25, Temple Row, Birmingham.

THE STRIKE of some 150 iron fitters and grinders at R. & A. Main's Gothic Works at Camelon, Falkirk, has been settled, and the men have returned to work. The dispute concerned overtime rates.

THE NEW cold rolling department at the Stocksbridge Works of Samuel Fox & Company, Limited, is nearly ready for work. The original building, which was recently badly damaged by fire, is being replaced by a modern iron and brick construction, which is expected to be ready by the end of next month.

IN A STATEMENT issued by the American Chamber of Commerce in London it is attempted to prove that the Fordney Tariff has not had the effect of barring British goods. For the first five months of the year most goods show substantial increases, while for ferro-alloys, etc., the figures are :—

	First 5 months, 1922.		First 5 months, 1923.	
	Tons.	Value. £	Tons.	Value. £
Ferro-alloys	23,854	280,805	46,592	672,997
Plates and sheets ..	1,030	28,690	8,650	184,463
Other manufactures	453	152,983	295	117,587

THE FEDERATION OF BRITISH INDUSTRIES has issued the third and final report of the Committee set up to examine the question of Inter-Imperial trade. This report deals with customs formalities throughout the Empire, and is therefore concerned rather with points of detail which in themselves may appear insignificant. Many of these points, however, represent a distinct source of annoyance and hindrance to traders, and are at the same time comparatively easy of adjustment. This is especially the case with regard to the admission of catalogues and printed advertising matter into countries throughout the Empire. Two other points of the importance referred to in the memorandum are the question of a standard customs classification and valuation.

THE PROGRAMME of the Institute of Metals for the session 1923-24 includes over thirty lectures and addresses, one being a lecture by Dr. F. W. Aston, which is to form part of the proceedings of next year's Empire Congress of Mining and Metallurgy. The subjects of the lectures are of a varied character, and include "Extrusion Problems," "Nickel Brasses," "Some Impressions of American Non-Ferrous Metallurgy," "Metals for Lamp Manufacture," "X-Rays and Metallurgy," "General Scientific Brass Foundry Work," "Alloys for use with Superheated Steam," "The Density of Alloys," "The Annealing of Non-Ferrous Metals," "The Action of Molten Brass on Nickel Steel," "Propeller Brass," "Large Metallic Crystals and Some of their Properties," "The Cold Working of Metals," "Electric Resistance Furnaces," "Substitutes for Platinum," "The Metallurgical Microscope," and "Influence of Casting Temperature on the Physical Properties of Metals."

THE LEEDS FORGE COMPANY, LIMITED, have invited subscriptions for £400,000 6 per cent. debenture stock at 95 per cent., the list closing on October 12. The issue is being made in order to pay off the 8 per cent. debenture stock on January 1 next, and any surplus will be used for further working capital. Holders of the 8 per cent. debenture stock may convert their holdings into an equal amount of the new stock at the rate of 95 per cent., and they will receive in addition £5 in cash for every £100 of stock converted, together with adjusted interest to date. Special consideration will be given to applications for the 6 per cent. stock from holders of the 5 per cent. first debentures and preference and ordinary shares of the Leeds Forge Company and from holders of the debenture stocks and shares of Cammell, Laird & Company, Limited, for any stock not taken up by the 8 per cent. debenture-holders. The 6 per cent. debenture stock will be paid off at par at the end of 1950, and the right of redemption at 102 per cent. after January 1, 1930, is reserved.

Personal.

PROFESSOR H. LOUIS has been elected chairman of the North-East Coast Local Section of the Institute of Metals in succession to the hon. Sir Charles A. Parsons, and Mr. H. J. Young has been elected vice-chairman in succession to Prof. Louis.

MR. JAMES SMITH, of South Shields, has been elected president of the Newcastle and District Branch of the Institute of British Foundrymen, with Mr. J. W. Frier, of Wallsend, as senior vice-president, and Mr. M. B. Herbst, Corbridge, junior vice-president.

MR. JAMES VALENTINE ELLIS, the general manager of the Workington branch, and Mr. James Henderson, the managing director of the Frodingham and Appleby companies, have been elected directors of the United Steel Companies, Limited, in place of Mr. Henry Steel, resigned, and the late Mr. Wm. Tozer.

MR. THOS. E. C. LINTERN, who has for nearly six years been works manager at the Shotts Iron Company's works at Shotts, Lanarkshire, has now been appointed general manager of the Clyde Ironworks, Glasgow, and the Calderbank Steel Works, Calderbank, of James Dunlop & Company, Limited. A short time ago Mr. Lintern's younger son, Mr. R. T. Lintern, was appointed steelworks manager of Wm. Beardmore & Company's works at Mossend.

MR. ROBERT RUSSELL, who has been in ill-health for some time, has resigned his position as chairman and managing director of the Coltness Iron Company, Limited. He has also resigned his directorship of the Alquife Mines and Railway Company, Limited. Mr. Archibald Russell, who was also on the directorate of the Coltness and Alquife Companies, has likewise severed his connection with them. Mr. Telfer, who has been connected with the Wilsons & Clyde Coal Company, Limited, has been appointed general manager of the Coltness Iron Company, Limited.

Wills.

CARBUTT, F. C., a director of the Stanton Ironworks Company, Limited £130,843

JOHNSON, COLONEL HERBERT ALFRED, of the Bradford Iron Works, Manchester, and the Ambergate Wire Works £320,197

Company News.

H. Andrews (Tyseley), Limited, Wharf House, Tyseley, Birmingham.—Capital £2,000 in £1 shares. Metal merchants, etc.

Electromobile Engineering Company (West Bromwich), Limited, 402, High Street, West Bromwich.—Capital £2,000 in £1 shares.

Ryland & Alder, Limited, 59, Aston Brook Street, Birmingham.—Capital £2,500 in £1 shares. Brassfounders, stampers and piercers, etc.

Failsworth Metal Company, Limited, 32, Victoria Street, Manchester.—Capital £1,000 in £1 shares. Directors: P. L. Cobe and F. W. Meredith.

Byers & Sons, Limited.—Capital £1,500 in £1 shares. Engineers, iron and steel merchants, etc. Directors: E. C. Byers, 34, Side Clift Road, Sunderland; A. K. Byers and A. W. Byers.

Central European Metal Corporation, Limited.—Capital £100,000 in 10s. shares. Directors: C. S. Goldman and A. H. Moreing. Solicitors: Leader, Plunkett & Leader, 76, Newgate Street, London, E.C.

Hattersley (Ormskirk), Limited.—Capital £50,000 in £1 shares, to acquire the business carried on at Ormskirk, Lancs., and at Halifax, Yorks., as the United Brassfounders and Engineers, Limited, and to adopt an agreement with R. E. Hattersley.

William Prestwich & Sons, Limited, The Gosforth Foundry, Calleywhite Lane, Dronfield, near Sheffield.—Capital £50,000 in £1 shares. Mineral merchants, etc. Directors: W. Prestwich, W. C. Prestwich, R. G. Prestwich (managing director), and A. Prestwich.

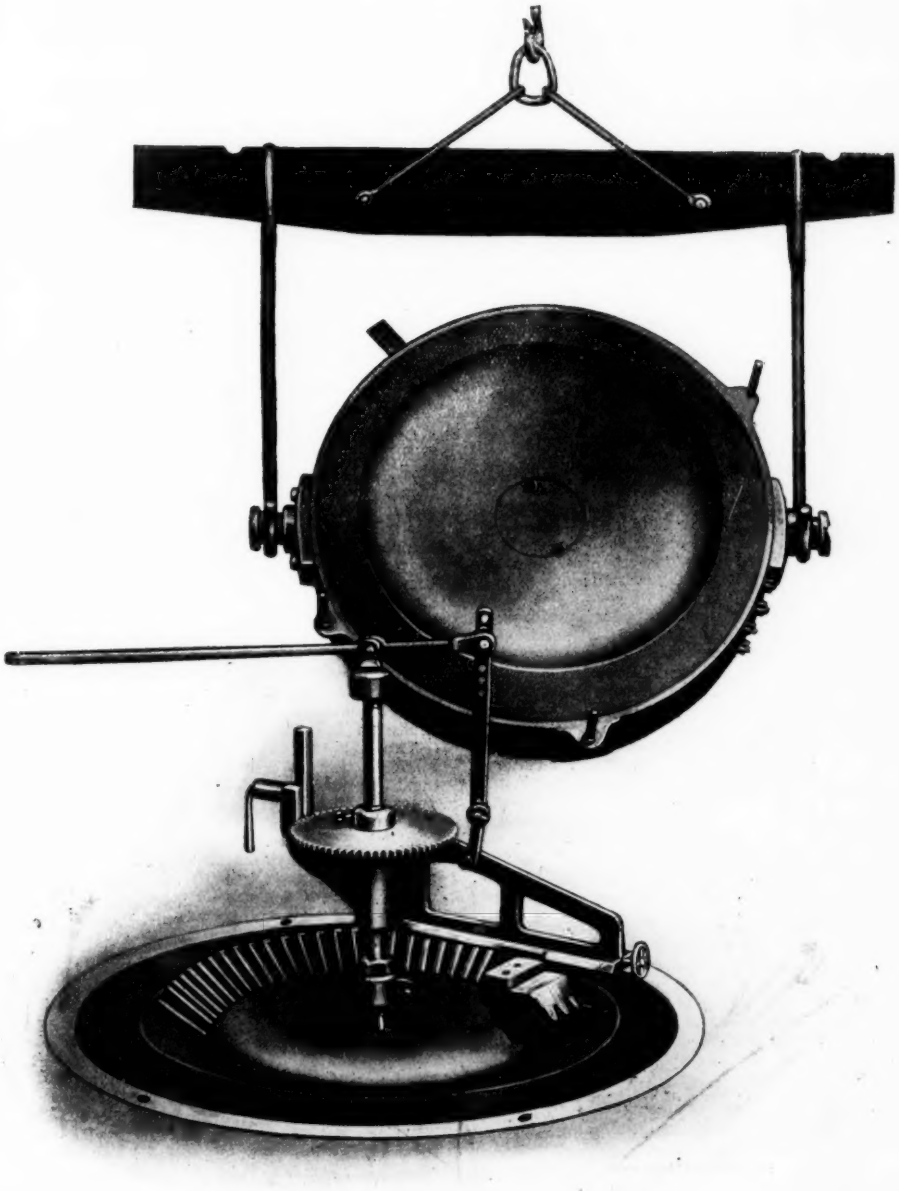
H. & J. Hill (Willenhall), Limited.—Capital £30,000 in £1 shares, to take over the business of general ironfounders carried on under the style of H. & J. Hill. Directors: H. Hill, J. Hill and A. F. Hill. Solicitors: Rowland, Tildesley & Harris, 1, New Road, Willenhall.

Vulcan Foundry, Limited.—Balance to credit of revenue reserve account, after payment of dividends for year ended June 30, 1922, £157,080; final preference dividend, 2½ per cent., making 5 per cent. for year; final ordinary dividend, 10 per cent., making 15 per cent. for year; revenue reserve account increased to £175,889.

Bengal Iron Company, Limited.—Net profit, including £21,703 brought forward, £308,402; depreciation and colliery sinking fund, £31,125; debenture interest, £41,345; written off debenture issue expenses, £43,283; taxation reserve, £5,000; general reserve, £15,000; preference share dividends, £37,500; ordinary dividend, 7 per cent. for year, less tax, £110,182; carried forward, £24,965.

The "VULCANIA" PATENT WHEEL MOULDING MACHINE.

Patent No. 5049.



THE "VULCANIA" PATENT WHEEL MOULDING MACHINE is for moulding spur wheels with straight, sloping or Vee-shaped teeth, also bevel wheels, skew gear wheels, worm wheels and internal wheels. The machine head is carried on a pillar which is held in a base-plate bedded in the floor sand, and is made to slide on the pillar by means of a lever and link carried on a joint bearing, or by rack and pinion, or screw if thought advisable for the particular work it is being used for.

An adjustable stop collar is provided for accurately deciding the depth of mould. On the removable head a slide is carried for supporting the patterns of the teeth to be moulded. This slide is made adjustable by screw or pinion gearing to the diameter required. The number of teeth to be moulded is decided by a special dividing plate into which a steel wedge or finger engages. The special dividing plate has milled vees, at the angle of 60° inclusive, around its circumference, to receive the steel wedge, which is adjusted by a screw having an internal spring to keep it in tension and to lock the head when ramming operations are being carried out.

JAMES EVANS & CO., BRITANNIA WORKS (MANCHESTER), LIMITED.

BLACKFRIARS, MANCHESTER.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—Slightly more activity may be reported in the Cleveland iron market during the past week, with some revival of inquiry from abroad, the tone throughout indicating a much steadier tendency than of late. The most important feature of recent movements is unquestionably an increasing interest on the part of consumers in forward buying, suggesting the inference that prices are for the present presumably at the lowest levels likely, at all events, to be attained this year. Another factor to be taken into account in the position is an easier tendency in fuel prices, while the approaching ascertainment for the current quarter should give some relief in the matter of wages under the sliding scale. On the export side, also, pig-iron shipments show a more satisfactory return, the aggregate from the Port of Middlesbrough during September having amounted to 34,827 tons (including Skinningrove, 4,113 tons), the total being just 31 tons more than in August. The exports to Germany were down from just over 15,000 tons to 3,983 tons, but there was a substantial increase in the shipments to Scandinavia, Sweden taking 4,067 tons, and Norway 1,205 tons. Among other larger buyers, Belgium took 2,603 tons, Danzig 2,125 tons, Italy 1,800 tons Switzerland 1,200 tons, and the U.S.A. 3,200 tons. Meantime, there is a reduction in quotations. At this market, No. 3 G.M.B. was offering freely at 95s. 6d. per ton, though there are one or two makers inclined to hold out for 96s. No. 4 foundry could be done at 91s., and for No. 4 forge 88s. 6d. may be regarded as an outside figure. No. 1, however, is scarcer than ever, and the price has hardened to 102s. 6d., while silicious is firm at 100s. per ton.

Hematite is very steady, with the price of mixed numbers unchanged at about 98s. 6d. per ton, though the tendency, if anything, is upward, some makers now quoting 99s. There is little if any excess of output just now, stocks are lower, and the production substantially reduced. Already, business is looking up in the home trade, and export demand during the past week or two has certainly improved. On the whole, therefore, the prospect is one of increasing values rather than otherwise, though much depends upon an early peace in the shipbuilding industry. In West Cumberland and North Lancashire hematite values have a hardening tendency, and Bessemer mixed numbers are quoted at £5 10s. per ton, delivered at Glasgow and Sheffield, and £5 15s. per ton at Birmingham. The buying nearly all comes from the Midlands, Scotland and South Wales.

MANCHESTER.—Although the foundry industry of the district continues in an unsatisfactory condition, there seems to be a tendency among pig-iron consumers to enlarge forward commitments, and buying to cover requirements for the last quarter is reported in slightly better volume. There has been of late some accumulation of foundry iron at the Midland furnaces, and this tends to make sellers a little easier, but few smelters quote less than 91s. at the furnaces, and the theoretical price is still 92s. 6d. There has been a slight tendency to put up the local prices for Scotch foundry iron, and some sellers now ask £5 17s. per ton for No. 3, delivered; this means a difference of nearly 20s. per ton between the Scottish and the Midland irons in this market, and tends still more to reduce the consumption of the former, which has been falling for some time in Manchester.

THE MIDLANDS.—At Birmingham last week there were indications of a more general and broader inquiry and a slight increase in turnover, but there was not sufficient movement of business to carry higher rates. In some cases the attitude of sellers was firmer, but against this it seems certain that it was still possible to shade some quotations a little. Current quotations: Northamptonshire forge, 82s. 6d.; No. 3 foundry, 90s.; Derbyshire forge, 84s.; No. 3 foundry, 92s. 6d.; all net f.o.t. furnaces.

SCOTLAND.—At Glasgow, also, the pig-iron market appears to indicate a more active tendency, forward buying into next year being reported, if only on a limited scale, chiefly confined, however, to consumers having orders on hand justifying this movement. On the other hand, there are quite a number of founders who are absolutely idle, and in these cases the management fail to find justification for coming into the market in the meantime. Prices are steady at 100s. at furnaces for No. 3. In hematite mixed numbers of Scotch iron are quoted at 102s. 6d., delivered steelworks. The Falkirk foundries have not been buying to any extent this week.

Scrap.

Corresponding with increased activity in pig-iron, the various markets for scrap material have developed a firmer tone than has been experienced of late, and in the Midlands there is a considerably better demand for cast-iron qualities for use in the foundries, and sellers have no difficulty in getting 92s. for the better qualities and 67s. 6d. for the lighter. In Lancashire, however, the actual supply of cast-iron scrap is limited, but it is more than enough for the foundries so long as the latter are kept short of work. The current prices for broken machinery metal range from 77s. 6d. to 85s. per ton, the latter price being for specially good lots. Steel turnings are in fair demand at about 70s. to 72s. 6d. per ton, and ordinary heavy melting steel scrap ranges from 72s. 6d. to 82s. 6d., according to position. Inquiries for all classes of cast-iron scrap for Scottish founders are still in the market, and here, again, supplies are not nearly sufficient to meet the demand. Heavy machinery metal is difficult to secure, also scrap railway chairs, and would doubtless find a ready market at under 92s. 6d. per ton. Ordinary cast-iron scrap is somewhat firmer around 82s. 6d. to 83s. 6d., and furnace firebars at 65s. to 67s. 6d.

Metals.

Copper.—Market conditions for standard copper within the past week have developed on irregular lines, with values inclining to lower levels. Movements indicating a heavy volume of selling have weakened buying, while the American market position has also had an adverse effect in this direction. Demand on consumptive account continues insufficient to warrant any sustained advance, and until there is some definite improvement in this direction prices seem likely to fluctuate within narrow limits. Stocks of copper on October 1 totalled 28,453 tons, an increase of 773 tons on last month's figure. Current quotations:—*Cash*: Thursday, £61 12s. 6d.; Friday, £62 5s.; Monday, £61 10s.; Tuesday, £60 7s. 6d.; Wednesday, £59 17s. 6d. *Three Months*: Thursday, £62 5s.; Friday, £62 17s. 6d.; Monday, £62 2s. 6d.; Tuesday, £61 2s. 6d.; Wednesday, £60 12s. 6d.

Tin.—At the beginning of last week values of standard tin experienced a sharp advance, a movement continued until £204 was attained, the highest point touched since May last, and in the meantime the quotation has fallen as low as £176 3s. 9d. Realisation on speculative account and lack of genuine trade demand have since had a weakening effect, and markets have been irregular. Near tin was at one time in strong demand, but the high prices attracted sellers, and the inquiry has since subsided. Backwardation, however, although lessened considerably, is still in evidence.

Ricard & Freiwald's statistics of tin for September are appended:—

Stocks, Landing and Afloat, Europe and America.—United Kingdom: Stocks in London, 1,587 tons; stocks in other ports, 1,422 tons; total, 3,009 tons. Landing and in transit, 95 tons; afloat from Straits, 715 tons; afloat from Australia, 60 tons; total United Kingdom, 3,879 tons. Holland: Banca spot, 1,975 tons; Banca and/or Billiton afloat to Europe and America, 729 tons. Continent: Straits afloat, 500 tons. United States: Spot and landing, 2,362 tons; afloat, 8,005 tons. Total visible supply, 17,450 tons. Current quotations:—*Cash*: Thursday, £204; Friday, £205 15s.; Monday, £205 10s.; Tuesday, £206; Wednesday, £203 5s. *Three Months*: Thursday, £202 10s.; Friday, £203 15s.; Monday, £202 15s.; Thursday, £202 5s.; Wednesday, £199 10s.

Spelter.—The market for this metal continues steady, with fluctuations in values confined within narrow limits. Rudolf Wolff & Company report that the demand on the part of consumers in this country has been very quiet; the market on the Continent, however, exhibits a certain firmness, a rather better demand being reported, while producers there still maintain an independent attitude. On October 1 stocks of spelter were given as 803 tons, a decrease of 204 tons compared with returns for the previous month. Current quotations:—*Ordinary*: Thursday, £32 15s.; Friday, £32 17s. 6d.; Monday, £32 15s.; Tuesday, £32 10s.; Wednesday, £32 5s.

Lead.—Business in soft foreign pig has been on a fairly active scale, with quotations firmly held. Arrivals during the current month have been heavy, but surplus metal, if any, is well controlled, and the premium on prompt delivery has actually increased. Stocks of lead on October 1 are officially given as 1,439 tons, a decrease of 280 tons. Current quotations:—*Soft foreign (prompt)*: Thursday, £26 7s. 6d.; Friday, £26 10s.; Monday, £26 10s.; Tuesday, £26 10s.; Wednesday, £26 7s. 6d.